



USER GUIDE

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LANSDALE FOCUS FACTORIES - PRODUCT ACCEPTANCE USER GUIDE

1.0 Purpose:

This user guide defines the workmanship criteria to be utilized in the fabrication and inspection of electrical and/or mechanical parts within the Sensor and Antenna Systems, Lansdale (SASL) facility.

2.0 Scope:

The inspection criteria contained herein shall be used for incoming, in-process and final inspection operations.

3.0 General:

This document is the Lansdale facility interpretation of workmanship criteria as defined by military standards and specifications, industry standards and general quality workmanship.

Inspection shall be performed in accordance with the sampling plan specified in the TipQA Inspection instruction.

4.0 Reference Documents

AMS 2422	Plating, Gold
AMS 2700	Passivation of Corrosion Resistant Steels
AMS QQ-P-35	Passivation Treatment for Corrosion Resistant Steels
AMS-W-6858	Welding, Resistance: Spot and Seam
ASME Y14.5.1M	Dimensioning and Tolerancing
ASTM-B-488	Electrodeposited Coatings of Gold for Engineering Uses
AWS A 2.4	Symbols for Welding, Brazing and nondestructive Examination
AWS A 3.0	Standard Weld Terms and Definitions
FED-STD-595	Colors Used in Government Procurement
IPC-A-610	Acceptability of Electronic Assemblies
IPC/WHMA-A-620	Requirements and Acceptance for Cable and Wire Harness Assemblies
MIL-A-8625	Anodic Coatings
MIL-C-5541	Conversion Coatings
MIL-F-14072	Finishes for Ground Based Electronic Equipment
MIL-P-9400	Plastic Laminate and Sandwich Construction Parts and Assembly, Aircraft Structural, Process Specification Requirements
MIL-HDBK-454	Standard General Requirements for Electronic Equipment
MIL-STD-202	Test Methods for Electronic and Electrical Parts
MIL-STD-403	Preparation for and Installation of Rivets and Screws. Rocket and Missile Structure.
MIL-STD-750	Test Method Standard for Semiconductor Devices
MIL-STD-883	Test Method Standard for Microcircuits
MIL-STD-2219	Fusion Welding for Aerospace Applications
MIL-STD-13231	Marking of Electronic Items
NAS 1400	Rivet-blind, Self-Plugging Mechanically Locked Spindle
NASM33537	Insert, Screw Thread, Helical Coil
NASM45938	Nut, Plain, Clinch and Nut, Self Locking Clinch, General Specification

5.0 Order of Precedence:

In the event of conflict between this user guide and any applicable document the order of precedence shall be as follows.

- 1) Contract/Purchase Order
- 2) Approved PDM controlled Drawing Prints and Hardware Parts
- 3) User Guide 6-044LPA
- 4) User Guide 6-044LPA reference documents

6.0 General Workmanship Requirements

- 6.1 It is the responsibility of the user of this Product Acceptance procedure to verify the calibration status of all measuring and test equipment to be used prior to its use.
- 6.2 It is the responsibility of the supervisor of the area to assure that all personnel, having a need to assemble, fabricate or manufacture product to meet these product acceptance criteria, or having a need to inspect material/product to meet these product acceptance criteria, have been trained to these requirements.
- 6.3 It is the responsibility of the supervisor of the area to assure that any special training/certification requirements such as soldering, welding, etc. have been completed prior to having personnel perform work to these product acceptance criteria.
- 6.4 It is the responsibility of the user of this Product Acceptance procedure to assure that all ESD requirements as required per 1611224 are being met, when applicable to the material/product being inspected.
- 6.5 It is the responsibility of the user of this Product Assurance procedure to assure that the correct magnification requirements are being used for each inspection type.

7.0 Handling and Packaging Requirements

- 7.1 It is the responsibility of the user of this Product Assurance procedure to assure that all purchased material is in a proper container or is packaged to prevent damage through handling or transit (Ref.: Supplier Packaging Requirement Codes – DI6-015LPA).
 - 7.1.1 Packaging is damaged. (GN07)
 - 7.1.2 Packaging is not as specified by Supplier Packaging Requirement Code on purchase order. (GN03)
- 7.2 It is the responsibility of the user of this Product Assurance procedure to assure that all material/product being manufactured, tested or inspected in the Lansdale facility meets the handling and packaging requirements of DI5-064LPA. The user shall immediately notify their supervisor of any handling or packaging concerns so that they can be remedied. (GN03)

8.0 INSPECTION OF MACHINED PARTS – VISUAL AND DIMENSIONAL INSPECTION REQUIREMENTS

8.1 General Requirements

All visual and dimensional inspections performed on material or product manufactured by or purchased for use in the Lansdale facility shall be in accordance with the requirements of this product acceptance procedure.

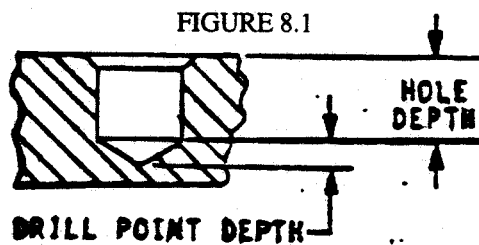
- 8.1.1 All dimensions apply after processing of machined parts and when parts are free from external stress other than that required to support parts, which due to their nature would otherwise sag or not hold their shape.
- 8.1.2 Dimensions shall apply in the restrained condition when the restrained condition and method of restraining are specified by drawing, Program Task Description (PTD), or specified by process as authorized by program.
- 8.1.3 Processing includes all heat treating and finishing operations such as case hardening, annealing, aging, blasting, machining, plating, anodizing, painting, etc. and all dimensions shall be set as specified on the drawing. Confirm whether dimensions apply before or after these processing operations.
- 8.1.4 When performing a prefinishing dimensional inspection, the Inspector shall determine the finish allowance needed to assure that the machined part will meet the dimensional requirements after finishing. Unless dictated on the drawing or in the router, this preplating allowance shall be determined by the drawing notes detailing the finish requirements.
 - 8.1.4.1 As a general rule of thumb, the Inspector shall double the minimum finish thickness, unless the Inspector determines otherwise, and then subtracts that amount from the specification limits to determine the preplating dimensions.
 - 8.1.4.2 For all outside dimensions, the Inspector shall always double the minimum finish thickness and then subtract that amount from the specification limits to determine the preplating dimension for hole diameters. For all inside dimensions (e.g. holes), the Inspector shall always double the minimum finish thickness and then add that amount to the specification limits to determine the preplating dimensions.
 - 8.1.4.3 Unless the threaded holes are to be masked, the Inspector shall always multiple the minimum finish thickness by four (4) and then subtract that amount from the specification limits to determine the preplating dimension for threaded holes. Internal threads shall always be masked for plating unless specified otherwise on the drawing.
 - 8.1.4.4 The Inspector shall indicate the amount of plating allowance used on the Dimensional Inspection record form with the words, "Plating buildup will average _____ per side, etc."
- 8.1.5 Dimensions controlling points or intersecting surfaces apply before breaking of corners.
- 8.1.6 All fixtures used to perform inspections shall be set to a zero reference, prior to inspection measurements.
- 8.1.7 General Workmanship – All parts are to be free of burrs, sharp edges, scratches, tool marks, metal chips (DM22) and foreign matter (FD02). There are some cases where deburring is not allowed and the feature shall not be deburred – see drawing notes.

- 8.1.8 **Knees and Parallels** - These units are used as holding fixtures in the Inspection Area. They do not require calibration, but they need to be “inspected for wear, dings and nicks” when used to hold product for inspection. This is easily accomplished by visual examination and placing the respective unit on a granite surface plate and looking for non-linearity, concave or convex parameters, rust or any defect that could affect the measurement process. Over and above this visual examination, in cases where the tolerances of the product to be measured are equal to or better than ± 0.002 inches, (e.g. ≤ 0.002) a further check is necessary. The holding surface on the knee or parallel must be checked with the dial indicator/height gauge combination resting on a granite surface plate. At least three points need to be checked. If any points vary by greater than ± 0.0002 ”, the unit cannot be used as a holding fixture. If the knee must be rotated 90 degrees, as part of the inspection procedure, the surface must be checked (before product is attached) in both axes. There are certain circumstances that require the use of shims to align the product on the holding fixture. The same tolerance conditions as above apply and the same check on knee rotation should also apply.

8.2 Hole Dimensional Requirements

- 8.2.1 **Hole Diameters** - Holes delineated on drawings without a specified hole diameter tolerance shall conform to the drawing tolerance blocks. (DM02)
- 8.2.2 **Hole Gaging** - The dimension and tolerance specified for a hole shall not determine the actual size of the hole, but rather the size of the plug gages to be used to measure the hole. For example, for a hole dimensioned $0.250" \pm .005/.000$ a "go" measuring exactly $0.2498"$ shall enter to the full depth of the hole with no greater force than two (2) finger hand push fit, while a "no-go" gauge measuring $0.2548"$ shall not enter the hole. (DM09 or DM10)
- 8.2.3 **Hole Depth** - Hole depth is the depth of the full diameter, including spotfaces, countersinks, and counterbores. Hole depth shall be defined as shown in figure 8.1. Hole depths specified without a tolerance shall conform to the drawing tolerance blocks. (DM17)

Note 1: Hole depth is generally “minimum” for the thread. Maximum is allowed to break thru unless the drawing prohibits. Extra depth is for chip clearance.



Note 2: Drill point depth may vary depending upon the drill point angle used for most efficient drilling. A drill point depth of 0.3 times the nominal hole diameter is typical of general-purpose drills. For Soft-Cast Iron and some nonmetallic materials, drill point may be as high as 0.87 times the nominal hole diameter.

- 8.2.4 **Hole Location** - On drawings which define machining for, and assembly of threaded - in or pressed - in items such as threaded inserts, inserts, standoffs, cap nuts, etc., tolerance of location apply to the hole and not the item location. The assembled item shall be

within a tolerance of location not exceeding the sum of the hole location plus an assembly tolerance of either ± 0.005 " or the equivalent positional tolerance of 0.014" diameter. (DM01)

- 8.2.5 Hole Angularity - Threaded and unthreaded holes delineated, as perpendicular to a surface shall have a maximum permissible angularity of 1 degree (1°). (DM18)
- 8.2.6 Hole Surface Quality - Drilled holes shall be machined with a maximum 250-roughness height rating. (DM16)
- 8.2.7 Holes for Thread Preparation (diameters) – Consult with Process Engineering or manufacturer's recommendations for dimensions to be used for threaded inserts, etc. (DM02)

8.3 Counterbore Dimensional Requirements

- 8.3.1 Counterbore Depth on Curved Surface - Counterbore depth on a curved surface shall be measured from the lowest point on the surface. (DM20)
- 8.3.2 Counterbore Concentricity - Counterbore shall be concentric to hole within one-half the sum of the tolerances of the hole/counterbore. (DM20)
- 8.3.3 Counterbore Surface Quality - Counterbored holes shall be machined with a 250 maximum roughness height rating. (DM16)

8.4 Countersink Dimensional Requirements

- 8.4.1 Countersink Angles - All countersinks shall be produced with an angular tolerance as specified on the drawing. If none is specified or stated in the drawing tolerance block, then it shall be ± 2 degrees (2°). (DM20)
- 8.4.2 Countersink Concentricity - Countersink shall be concentric to hole within one-half tolerance of the hole diameter. (DM04)
- 8.4.3 Countersink Surface Quality - Countersink shall be machined with a 125 maximum roughness height rating. (DM16)
- 8.4.4 Countersink Stock Thickness - When stock thickness and countersink tolerances combine to produce a hole diameter which exceeds drawing requirements, the countersink takes precedence. (DM20)
- 8.4.5 Countersink Curved Surface - On a curved surface, the countersink shall be measured at the smallest points for size conformance. (DM20)

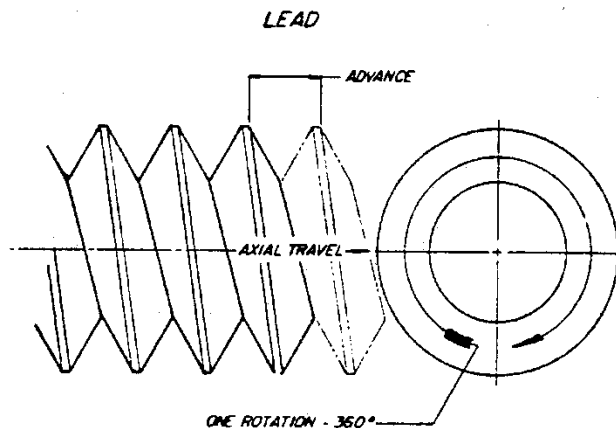
8.5 Spotfaces Dimensional Requirements

- 8.5.1 Spotface Depth - The depth of a spotface shall only be deep enough to remove sufficient material to clean and true a surface. When measured at the shallowest section, the depth shall be flush to not exceed 0.010". (DM20)

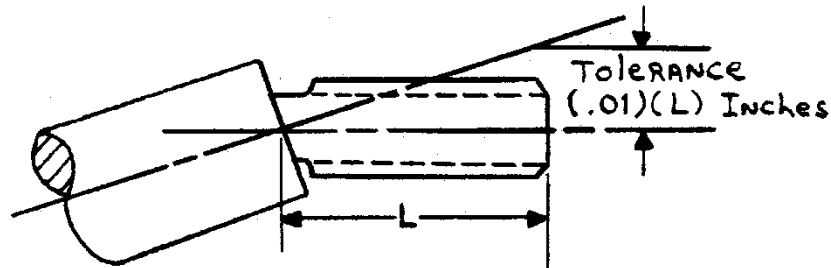
8.6 Screw Threads Dimensional Requirements

- 8.6.1 Screw Thread Gaging - Internal and external threads shall be inspected using the appropriate class "GO", "NO-GO" thread gages. A maximum of 3 turns of the "no-go" gage will be allowed. Drag encountered with "no-go" will be considered nonacceptance of the gage and an acceptable thread. (DM09 or DM10)

- 8.6.2 Screw Thread Chamfers - External threads shall be chamfered 45 degrees \pm 10 degrees to the minor diameter of the thread. Internal threads shall be countersunk 100 degrees \pm 20 degrees to the major diameter of the thread. Diameter tolerance to be $+0.020''/-0.000''$. (DM20)
- 8.6.3 Screw Thread Length - Thread length shown or specified on an engineering drawing is for minimum gage fit. Two perfect or imperfect thread leads beyond this limit are permitted on external threads for lead of die. Five perfect or imperfect thread leads beyond this limit are permitted on internal threads for lead of tap. Where parts are shown threaded to a shoulder, the length of perfect thread shall be within two thread leads of the shoulder. Internal thread depth is measured from the base material surface for countersunk holes and from the flat machined surface of counterbore holes. (DM01)
- 8.6.4 Screw Thread Surface Quality - The finish on a screw thread shall be machined, at a minimum, with a 125-roughness height rating. (DM16)
- 8.6.5 Screw Lead Definition - Screw lead is defined as the amount of axial travel when the threaded part is turned one full turn or 360°. Reference figure 8.2. (DM11)

FIGURE 8.2

- 8.6.6 Screw Thread Perpendicularity - The axis of the threaded part shall be perpendicular with the shoulder or face within 0.010 inch of length (L) of threaded part. (See figure 8.3) Computed allowable variation shall be total for the length. Threaded holes shall have a maximum permissible deviation of ± 1 degree from true perpendicular. (DM18)
- 8.6.7 Thread Relief to a Shoulder. Any drawing showing a full thread to a shoulder with no relief depicted shall be relieved so that a gage will thread to a shoulder without interference. (DM11)
- 8.6.8 Thread Relief - When the term thread relief on shouldered screw applications is specified on the drawing, it shall be a maximum width of three (3) times the pitch (advance). The relief diameter shall be the minor diameter $+0.000''/-0.010''$. (DM11)

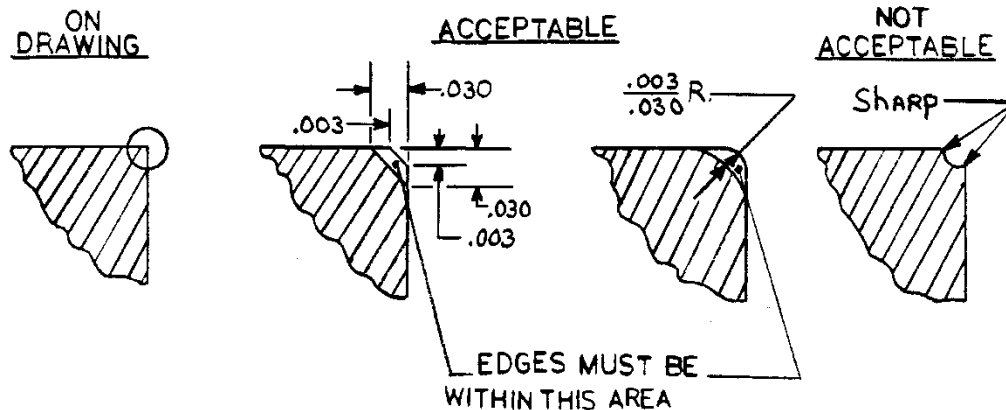
FIGURE 8.3**8.7 Burrs/Edges Dimensional Requirements**

- 8.7.1 Machined Edges – Unless drawing requirements dictate otherwise, breaking of edges is applicable to all machining operations, e.g. milling, turning, punching, shearing, forming, grinding, except for holes where rivets and pressed hardware are to be installed. (DM22)
- 8.7.2 Sharp Edges - A machined edge designated by the note "sharp edge", shall be interpreted to mean that either a chamfer or a radius up to but not including 0.003" is acceptable - the low limit shall be understood to be 0.000". (DM22)
- 8.7.3 Maximum - A machined edge designated by a dimension with the term "max" applied (e.g. 0.010" R max or .015 x 45 degree chamfer max) shall be produced with a radius or chamfer, as applicable, not more than the specified maximum size. The low limit shall be understood to be 0.000". (DM01)
- 8.7.4 Minimum - A machine edge designated by a dimension with the term "min" applied (e.g., 0.010" R min or .03 x 45 degree chamfer min), shall be produced with a radius or chamfer, as applicable, not less than the specified minimum size nor more than the specified minimum plus the proper increment in Table 8-1 (DM01)

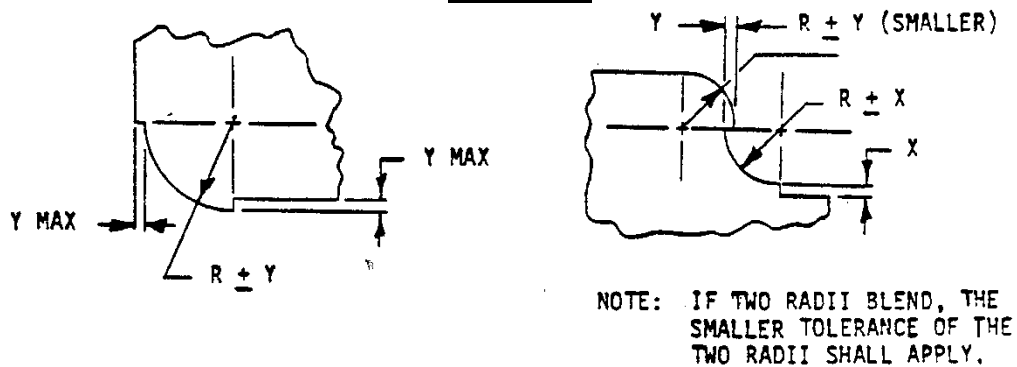
TABLE 8-1

Where Applicable	Increment
Two place decimal	.03"
Three place decimal between 0.005" and 0.015"	.015"
Decimal sizes up to 0.005"	.005"

- 8.7.5 Other - All internal and external machined edges not specifically designated by a dimension shall be broken to 0.003" minimum and 0.030" maximum chamfer or radius (see Figure 8.4) (DM01)

FIGURE 8.4

- 8.7.6 Louvers - Where louvered openings are punched/sheared, removal of sharp edges normally left in the opening is required only where such edges constitute a safety hazard or compromise the drawing requirements. (DM01)
- 8.7.7 Connecting Surfaces - All connecting surfaces, curved and plane surfaces, shown as tangent, must blend smoothly unless otherwise shown. Internal or external radii shown tangent to each other or tangent to a surface or edge shall not have a step at the function which exceeds one half the tolerance range of the radius. (See Figure 8.5) (DM01)

FIGURE 8.5

- 8.7.8 Burrs/Sharp Edges - Parts shall be free from burrs (UNLESS DIRECTED OTHERWISE ON THE DRAWING), or sharp edges that could make the part (or equipment) unsatisfactory for the purpose intended. Parts shall be visually inspected for burrs using a microscope set at 10X. (DM22)

8.7.8.1 Definition of a Burr

- Burrs are protruding irregularities, which cannot be considered part of the designed contour.
- A loose or hanging burr is one, which can be removed by fingernail pressure, or air blast.
- Swelling of material such as that caused by displacement of material shall not be considered a burr and shall be judged with respect to its effect on dimensional and functional limitations on the part and appearance.

- 8.7.8.2 Burrs on all metal and plastic parts shall be removed to the limits of this specification. (DM22)

- 8.7.8.3 Loose or hanging burrs shall be removed. (DM22)
- 8.7.8.4 Unless otherwise specified, all external surfaces and edges shall be free of burrs. Features internal to the product part which would not constitute a safety hazard may exhibit sharp edges. In general, any feature whose longest dimension is 3/8" or greater (hole diameters and/or cutouts) shall have its edges broken to 0.003" minimum and 0.030" maximum chamfer or radius. (See Figure 8.4) (DM22)

8.8 Undercuts Dimensional Requirements

- 8.8.1 Undercuts - When the term "UNDERCUT" is specified at an internal edge of a shoulder shaft as shown in Figure 8.6, undercut dimension of Table 8-2 shall apply. No sharp edge shall be present in undercut. (DM16)

FIGURE 8.6

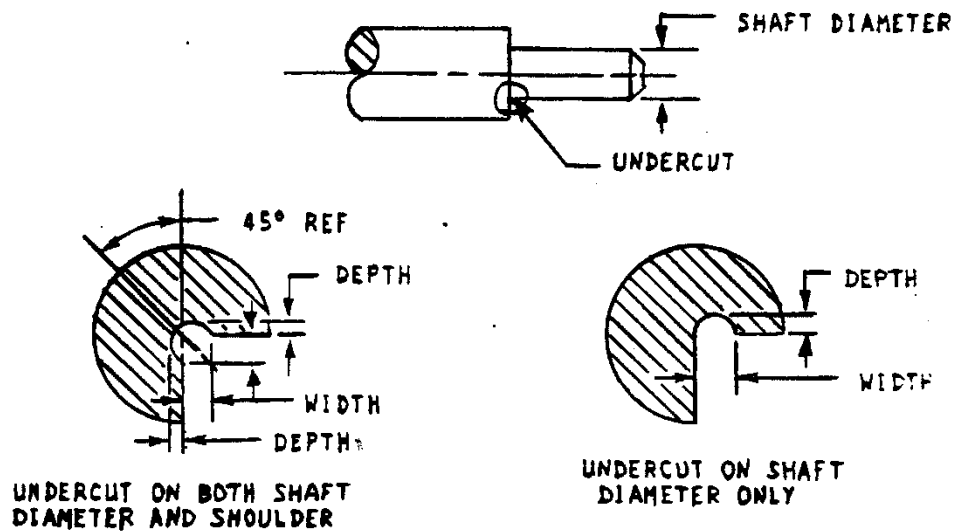


TABLE 8-2

Finished Shaft Dia.	Depth of Undercut	Width of Undercut
0 to .125	.0015 to .003	.025 to .035
.126 to .250	.003 to .006	.025 to .035
.626 to .625	.005 to .010	.035 to .050
.626 to 1.000	.010 to .015	.050 to .070
1.0001 to larger	.015 to .031	.125 to 1.070

- 8.8.2 Undercuts Surface Quality - The finish on an undercut shall be machined with a 250 maximum roughness height rating. (DM16)

8.9 Surface Quality

- 8.9.1 Surfaces not specified shall be produced with a surface roughness not exceeding the applicable Roughness Height Ratings shown in Table 8-3. (DM16)
- 8.9.2 Unless otherwise specified, the effect of flaws such as cracks, blow holes, and checks shall not be included in the roughness height measurements. Flaws caused by machining, such as ridges, scratches, etc. shall be included in the roughness height measurement. Any acceptance of parts or material containing flaws will be at the discretion of MSPA Quality Assurance Engineering. (DM16)

TABLE 8-3

KIND OF SURFACE	ROUGHNESS HEIGHT RATINGS				
	1000	500	250	125	63
1. Bolt Head Surface and Unthreaded shanks of bolts.			X		
2. Chamfers, Radii, and Undercuts			X		
3. Counterbored Surfaces			X		
4. Countersunk Surfaces				X	
5. Drilled Holes			X		
6. Ends of Bolts, Pins, Screws and Studs				X	
7. Engraved Characters				X	
8. Gear Teeth					
a. 20 Diametral Pitch and Finer					X
b. Coarser than 20 Diametral Pitch				X	
9. Pipe Treads					X
10. Screwdriver Slots		X			
11. Screw Head Surface and Unthreaded Shanks of Screws					X
12. Sheared Surfaces, Sawed Surfaces	X				
13. Spot Faced Surfaces All Diameters			X		
14. (60) Screw Threads & Tapped Holes				X	
15. Machines Plastics			X		
16. Castings:					
a. Die				X	
b. Permanent Mold			X		
c. Precision				X	
d. Sand	X				
e. Shell Mold			X		
17. Forgings		X			
18. Misc. Machined Surfaces:					
a. tolerance less than .002 total					X
b. .002 to .006 total inclusive				X	
c. Over .006 total			X		

8.10 Geometric Tolerances

Geometric tolerances are expressed by the use of symbols in accordance with ANSI Y14.5. Where geometric features are not specifically covered by the symbol and tolerance on the drawings, the applicable tolerances specified herein shall govern. (DM01)

8.10.1 Governing Tolerances - Specified geometric tolerances on the drawing or in this specification restrict the variations of geometric characteristics of the surfaces of the part within the location and size tolerance limits. When geometric tolerances are not specified on the drawing or covered here in, the actual dimensions will be acceptable if it is within the dimensional limits specified, regardless of form variations. (DM01)

8.10.2 Datum Surfaces and Lines:

8.10.2.1 A datum surface of a surface referred to as a reference plane and shown on the drawing as being flat means that true plane which will rest on the actual surface in a manner that the extreme points of contact with the surface span the greatest distance or a true plane parallel to such a plane. If the actual surface is convex, without valleys, the reference plane is that true plane which will rest on the high point of the actual surface in a manner that the two lowest points are equidistant from it or a true plane parallel to such a plane, see Figure 8.7.

8.10.3 Flatness - Machined Surfaces - Unless otherwise specified, machined surfaces shall be flat within the limits specified in Table 8-4. Computed allowable variation shall be total for the surface. (DM08)

FIGURE 8.7

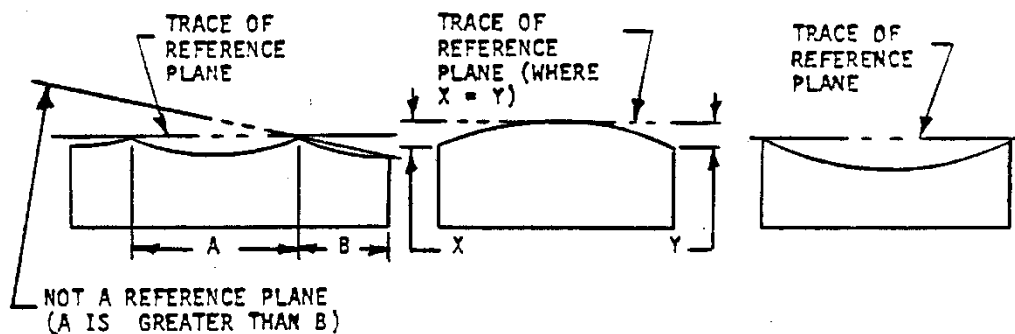


TABLE 8-4

* Surface Roughness Height Rating	Allowable Variation per Inch or Fraction of an inch	* Surface Roughness Height Rating	Allowable Variation per Inch or Fraction of an Inch
4	.0002	63	.0006
8	.0003	125	.0008
16	.0003	250	.0016
32	.0004	500	.0030

NOTE: * Refer to Table 8-4 unless specified on drawing.

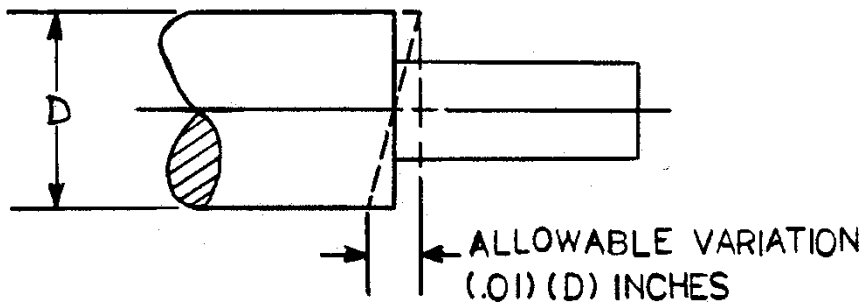
8.10.4 Parallelism - When machined cylindrical and/or plane surfaces are shown on a drawing as being parallel and are dimensioned one with respect to the other, they shall be produced parallel within half of these tolerances on the dimensions between the surfaces or axes. (DM09)

8.10.4.1 Casting Surfaces - When shown parallel, nondraft surfaces shall be produced parallel within 0.03" inch for surface less than 6 inches and 0.005" inch per inch or fraction of an inch for surfaces longer than 6 inches. Computed allowable variations shall be equal to the product of the total number of inches times the allowable variation per inch. (DM01)

- 8.10.5 Perpendicularity - When machined cylindrical and/or plane surfaces are shown on a drawing as being perpendicular with respect to each other, such surfaces shall be perpendicular within 0.001 inch per inch of surface or fraction of an inch. Computed allowable variation shall be equal to the product of the total number of inches times the allowable variation per inch. (DM18)

8.10.5.1 Perpendicularity of Ends - Faces and Shoulders on Turned Parts - Total deviation from axis shall not exceed 0.010" inch per inch of diameter, see Figure 8.8. Computed allowable variation shall be equal to the product of the total number of inches times the allowable variation per inch. (DM18)

FIGURE 8.8

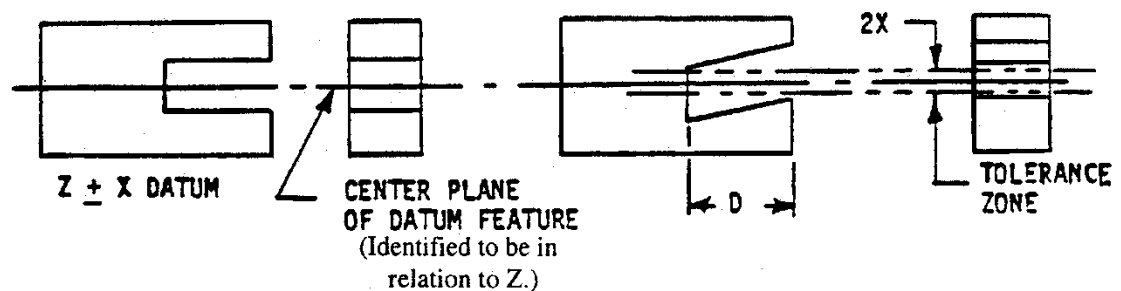


- 8.10.6 Concentricity - Two machined features shown on drawings as having a common axis shall be concentric within half the sum of the tolerances on the Diametral dimensions of those features. Concentricity tolerances shall be full TIR (total indicated runout). (DM04)

8.10.6.1 One machined and one non-machined feature with common axis shall be concentric within the sum of the tolerances on the two features, full TIR. (DM04)

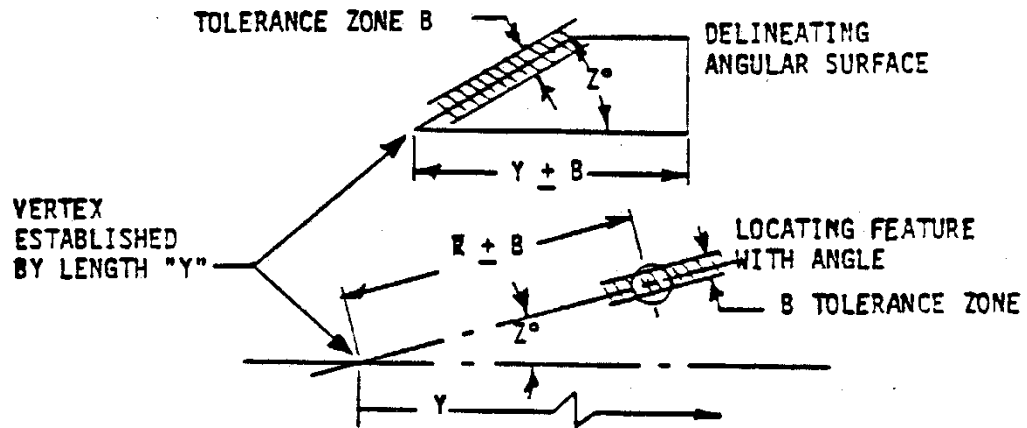
- 8.10.7 Symmetry - Unless otherwise specified, a feature which is shown to be symmetrical with a datum feature, and no locating dimension exists, shall be symmetrical within the tolerance applied to the datum feature, see Figure 8.9. (DM01)

FIGURE 8.9

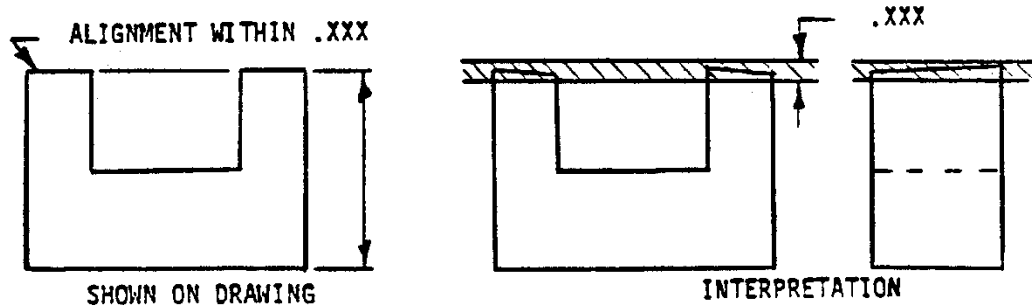


NOTE: In the example shown here the tolerance zone is bounded by two planes "2X" inches apart and equidistant from the center plane of the slot feature lying within the tolerance zone over the depth (D) of the slot feature. This illustration shows ones one extreme acceptable condition. (DM01)

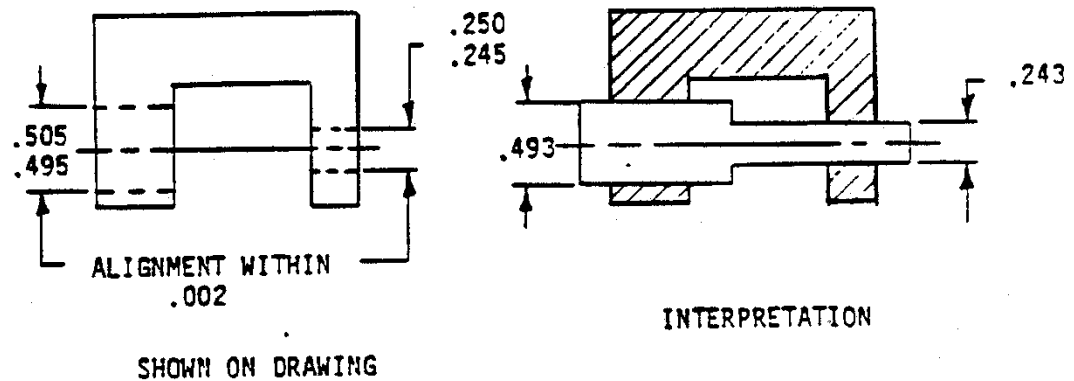
- 8.10.8 Angularity - Unless otherwise specified on the drawing, an angle shall have an angularity tolerance equal to half the tolerance of the dimension locating the feature, see Figure 8.10. Vertex shall establish the center plane of the tolerance zone. (DM18)

FIGURE 8.10

- 8.10.9 Alignment - Where specific alignment requirements are necessary, the surfaces of features are shown located by a common plane with an alignment specification as illustrated in Figure 8.11. Such surfaces or features located by a common plane shall satisfy the alignment condition if all points on each feature lie between two parallel planes separated by a distance equal to the deviation allowed by the alignment tolerance. (DM14)

FIGURE 8.11

- 8.10.9.1 When an alignment requirement is specified on two or more holes with a common axis, the alignment condition shall be satisfied by a straight, round, shaft, having a diameter equal to the minimum hole diameter specified for each hole minus the alignment tolerance, that can pass through the holes. (See Figure 8.12) (DM04)

FIGURE 8.12

9.0 INSPECTION OF SHEET METAL – VISUAL AND DIMENSIONAL INSPECTION REQUIREMENTS

9.1 General Requirements

All visual and dimensional inspections performed on material or product manufactured by or purchased for use in the Lansdale facility shall be in accordance with the requirements of this product acceptance procedure.

9.1.1 General Workmanship – All parts are to be free of burrs, sharp edges, scratches, tool marks, metal chips and foreign matter. (SM01)

9.2 Flatness - Unless otherwise specified, the product shall be flat within the values given in Table 9-1 from a reference plane, except for parts that due to their nature, sag or do not hold their shape, may be restrained. Variations shall be measured with the part resting on a surface plate with convex side of sheet metal up. Weights and clamps shall not be used. Only two waves having the values indicated in the table are permissible. Additional waves shall not exceed one-half the given values. (SM02)

TABLE 9-1

STOCK Thickness	PART SIZE				
	Less than 3"	3." to 10."-	10" to 24"-	24" to 48"-	Over 48"
.015 + to .040	.015	.040	.080	.160	---
.040 + to .093	.010	.030	.055	.110	.130
.093 + to .189	.008	.025	.040	.080	.130

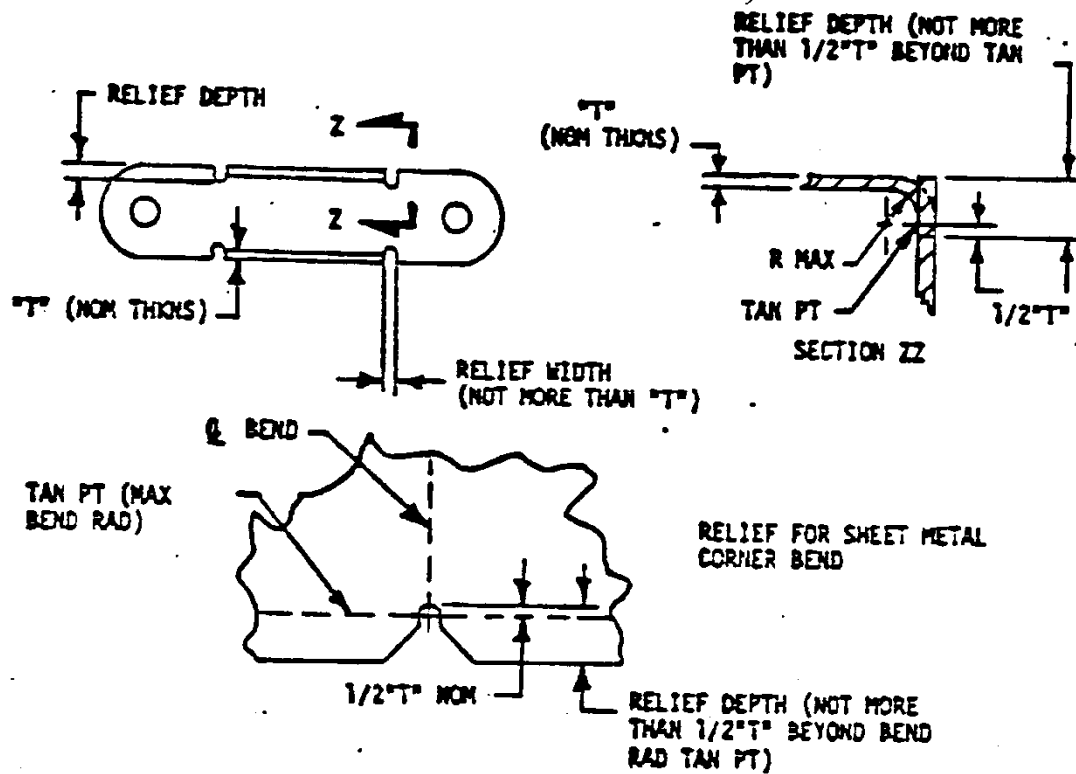
9.3 Parallelism - Surfaces shown as parallel shall be produced within 0.010 inch per linear inch, or fraction of an inch. Edges shown as parallel shall be produced within tolerance of size dimensions. (SM03)

9.4 Perpendicularity - Bends shown at right angles shall be produced perpendicular within 0.009 inch per inch, or fraction of an inch. (SM04)

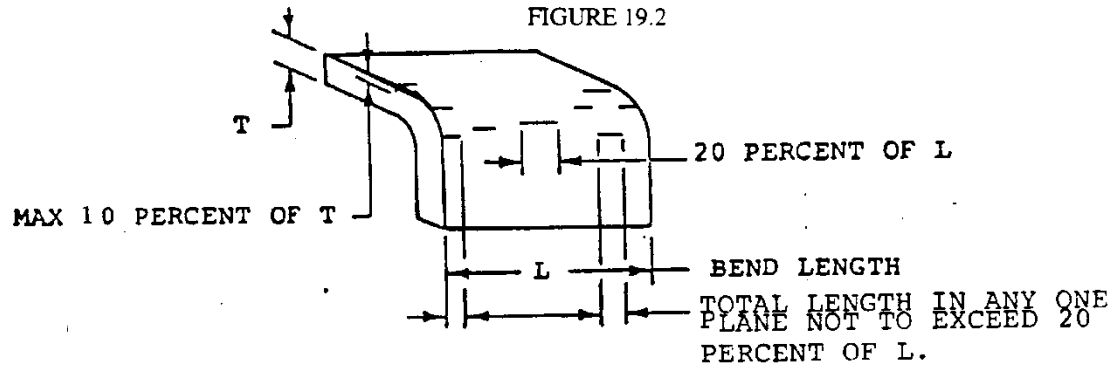
9.5 Bend Reliefs - Bend reliefs for all sheet metal bending are optional unless specifically called for on the drawing. Where optional bend reliefs are used, the width shall not exceed the nominal material thickness and the depth shall not exceed beyond the tangent point of the maximum specified bend radius by more than $1/2$ the nominal material thickness. (See Figure 9.1) (SM05)

9.5.1 Welding or filling of bend reliefs is not required unless specified on the drawing. (SM05)

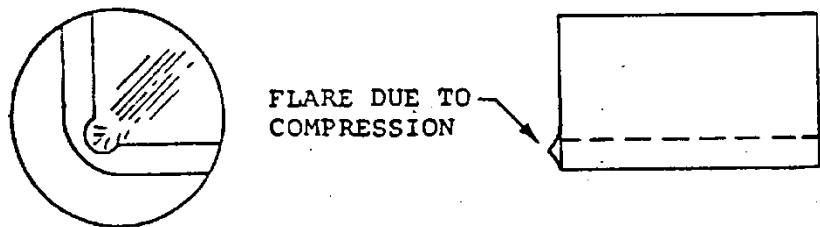
FIGURE 9.1



- 9.6 Bends** - Surface crazing is permissible, but the aggregate length in any plane shall not be in excess of 20 percent of the bend length. The depth of an imperfection shall not exceed 10 percent of the material thickness (Reference Figure 9.2) (SM05)

FIGURE 9.2

- 9.7 Flares** - Flares less than the maximum radius of the bend are permissible provided they do not exceed dimensional limits of the part. (Reference Figure 9.3) (SM06)

FIGURE 9.3

- 9.8 Punched Holes** - Round or slotted holes produced by punch may exceed the maximum limit of size specified on the drawing by breakaway value. The breakaway shall not be on the opposite side of a counterbore or countersink that would reduce maximum hole diameter length to less than $0.2T$. (Reference 9.4) Breakaway "A" is not permissible beyond maximum print diameter at pressed in hardware engagement. (Reference Figures 9.4 and 9.5 and Table 9-2) (SM07)

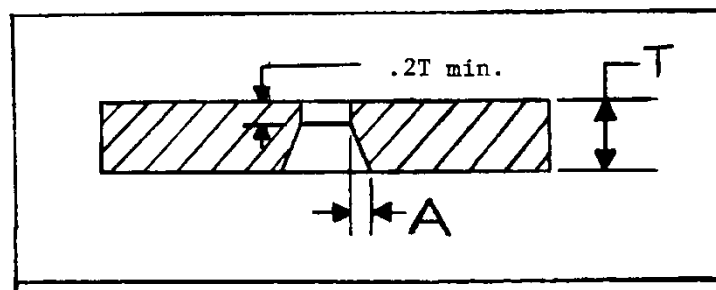
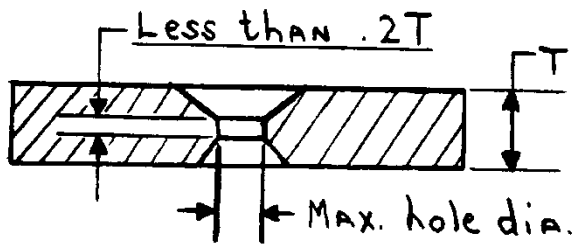
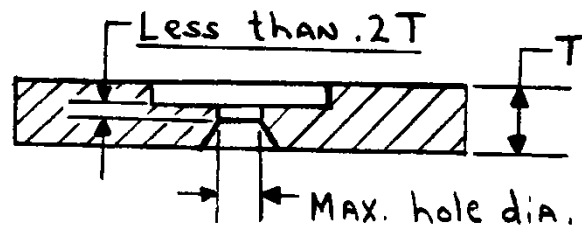
FIGURE 9.4

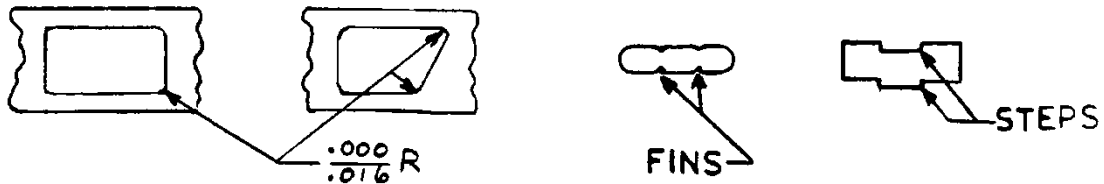
TABLE 9-2

NOM THICKNESS T	MAX BREAKAWAY A
Up thru .032	.002
Over .032 thru .063	.003
Over .062 thru .160	.008
Over .160 thru .249	.013

FIGURE 9.5

9.9 Other Shape Holes - Corners of square, rectangular or irregular shaped pierced holes, unless otherwise specified, shall have a fracture free 0.000" to 0.016" radius. Steps and fins, caused by nibbling of punches, are permitted with size limits. (See Figure 9.6) (SM07)

FIGURE 9.6



9.10 Connector Cutouts - Two types of connector cutouts are commonly used. Figure 9.7 shows the dimensions of the cutout going to a “hard-line” dimension or the farthest points when measured with an inspection tool. Figure 9.8 shows the dimensions of the cutout going to an intersecting point. (SM08)

When there are questions on whether the lines are drawn to the hard-line or intersecting dimension, it is our intention that the lines are going to the hard-line dimensions.

FIGURE 9.7

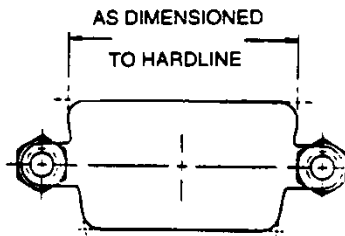
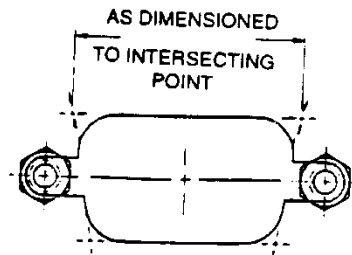


FIGURE 9.8



10.0 INSPECTION OF WELDING – VISUAL AND DIMENSIONAL INSPECTION REQUIREMENTS

10.1 General Requirements

All visual and dimensional inspections performed on material or product manufactured by or purchased for use in the Lansdale facility shall be in accordance with the requirements of this product acceptance procedure.

10.2 Fusion Welding

10.2.1 General

All welds shall be 100% visually inspected for fillet welds, beads, dressing and weld quality, i.e. discontinuities, by a certified inspector in accordance with 1611706. (Reference Table 10-1).

Each welded assembly shall be permanently marked with identification of the person performing the welding. If part cannot be identified, the route card will show welders identification when welded to a Military specification.

Note 1: Drawings which only have weld symbols and no specification should be inspected to the same workmanship requirements as Class C welds IAW SAE-AMS-STD-2219.

Note 2: Drawings which call out 'Weld IAW MIL-STD-454 requirement 9 should be inspected to the same workmanship requirements as Class C welds IAW SAE-AMS-STD-2219.

Note 3: Drawings which call out 'Weld IAW SAE-AMS-STD-2219' need to have a class designation (A, B, or C). Drawings with no class designation default to a Class A. Class A welds require nondestructive inspection, i.e. radiographic and either dye penetrant or magnetic particle techniques. Class B welds shall be inspected using dye penetrant or magnetic particle techniques.

10.2.2 Fillet Welds

Fillet weld size shall be as specified in the drawing and represent the minimum weld size. (GN24)

10.2.3 Beads

Beads shall be smooth and free of overlap, excessive undercut and spatter shall not terminate in inside corners. (GN24)

10.2.4 Dressing

Dressed welds shall be smooth to surface and blend smoothly with adjacent material. Removal of material during the cleaning operation shall not exceed the allowed tolerances of the end product specification. (GN24)

10.2.5 Weld Quality

Discontinuity shall not exceed the limits of Table 10.1 (GN24)

TABLE 10-1

IMPERFECTION	CLASS OF WELDS		
	A	B	C
Surface Porosity Individual size maximum	.025 T or 0.030 inch whichever is less	0.33 T or 0.060 inch whichever is less	0.50 T or 0.090 inch whichever is less
Spacing – Minimum	8 times the size of the larger adjacent imperfection.	4 times the size of the larger adjacent imperfection	2 times the size of the larger adjacent imperfection
Accumulated length in any 3 inches of weld- maximum	1 T or 0.12 inch whichever is less	1.33 or 0.24 inch whichever is less	2 T or 0.36 inch whichever is less
Undercut For full length of weld maximum depth	0.002 inch	0.015 or 0.0002 inch whichever is greater	0.025 T or 0.002 inch whichever is greater
Individual defect maximum depth	0.07 T or 0.030 inch whichever is less	0.10 T or 0.050 inch whichever is less	0.020 T or 0.070 inch whichever is less
Accumulated length in any 3 inches of weld - maximum	0.20 inch	0.60 inch	1.00inch
Underfill/concavity for full length of weld maximum depth	.005 inch	0.015 T or 0.005 inch whichever is greater	0.025 T or 0.005 inch whichever is greater
Individual defect maximum depth	0.07 T or 0.030 inch whichever is less	0.10 T or 0.050 inch whichever is less	0.020 T or 0.070 inch whichever is less
Accumulated length in any 3 inches of weld - maximum	.020 inch	0.60 inch	1.00 inch
Subsurface porosity and inclusions: Individual size maximum	0.33 T or -.060 inch whichever is less	0.50 T or 0.090 inch whichever is less	not applicable
Spacing – minimum	4 times the size of the larger adjacent imperfection	2 times the size of the larger adjacent imperfection	not applicable
Accumulated length in any 3 inches of weld - maximum	1.33 T or 0.24 inch whichever if less	2 T or 0.36 inch whichever is less	not applicable
Incomplete penetration: Maximum depth	None	0.20 T or 0.05 inch whichever is less	0.020 T or 0.05 inch whichever is less
Craters: Maximum depth	0.20 T or 0.03 inch whichever is less	-0.020 T or 0.05 inch whichever is less	0020 T or 0.05 inch whichever is less
Maximum length	1 T	1 T	2 T
Cracks:	None	None	None
Cold Shut:	1 T or 0.1 inch whichever is lesser	1 T maximum length	2 T maximum length

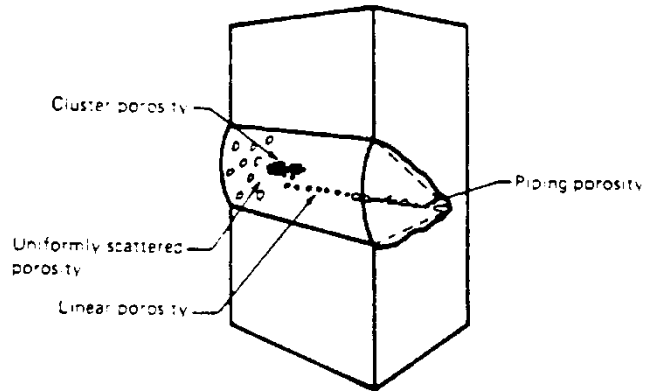
NOTES: 1) If the defects exhibit sharp radii, sharp termination, or are cracklike, they shall be removed by grinding. If the depression is not larger than permitted, they need not be rewelded.

2) Where possible to determine, by metal removal, the depth of cold shut shall not cause joint thickness to be less than the thinner material being welded.

10.2.6 Discontinuity Inspection Criteria and Definitions

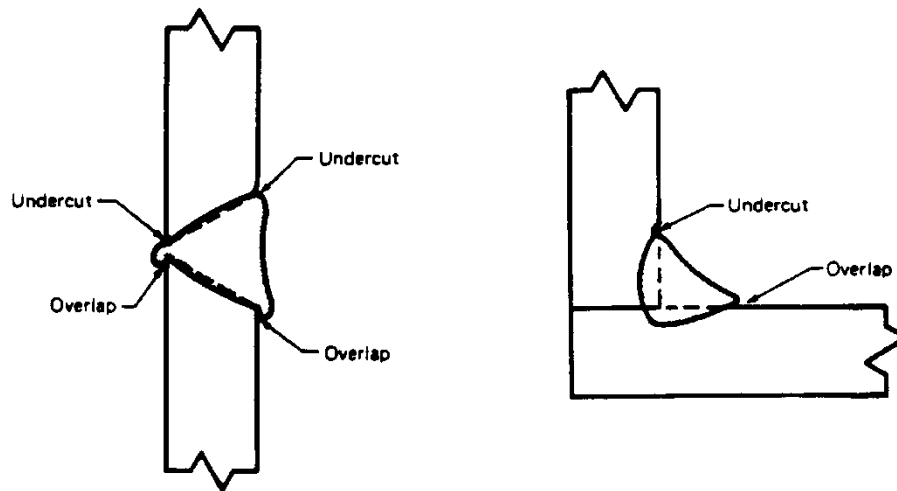
10.2.6.1 Surface Porosity - Elongated or globular voids. Cavity type (See Figure 10.1) discontinuities. (GN24)

FIGURE 10.1



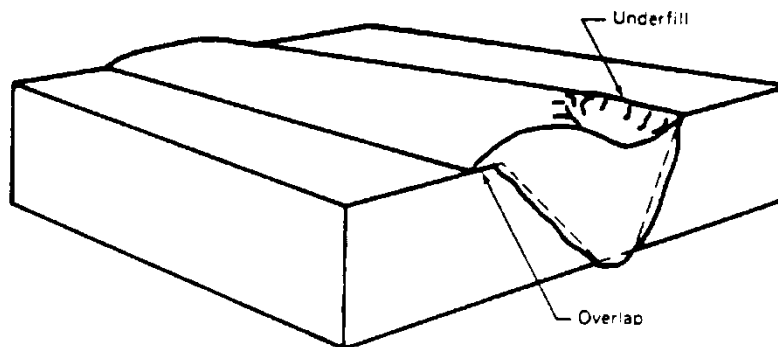
10.1.6.2 Undercut - Melting away of base metal at the fusion boundary between the metal and the base metal (See Figure 10.2) (GN24)

FIGURE 10.2



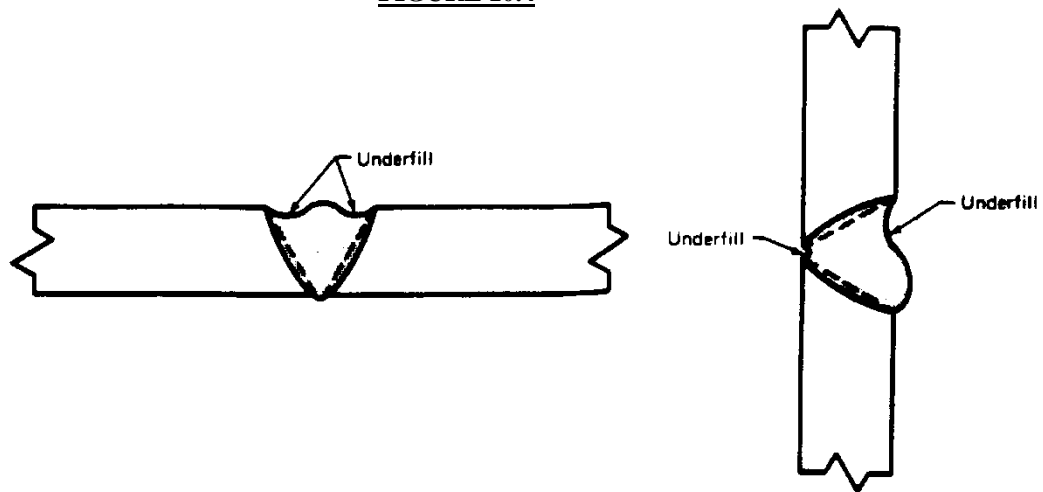
10.2.6.3 Overlap - Is a discontinuity that is sometimes called "Cold lap". The weld metal extends over, but does not fuse to, the base metal at the toe of the weld. (See Figures 10.2 & 10.3) (GN24)

FIGURE 10.3



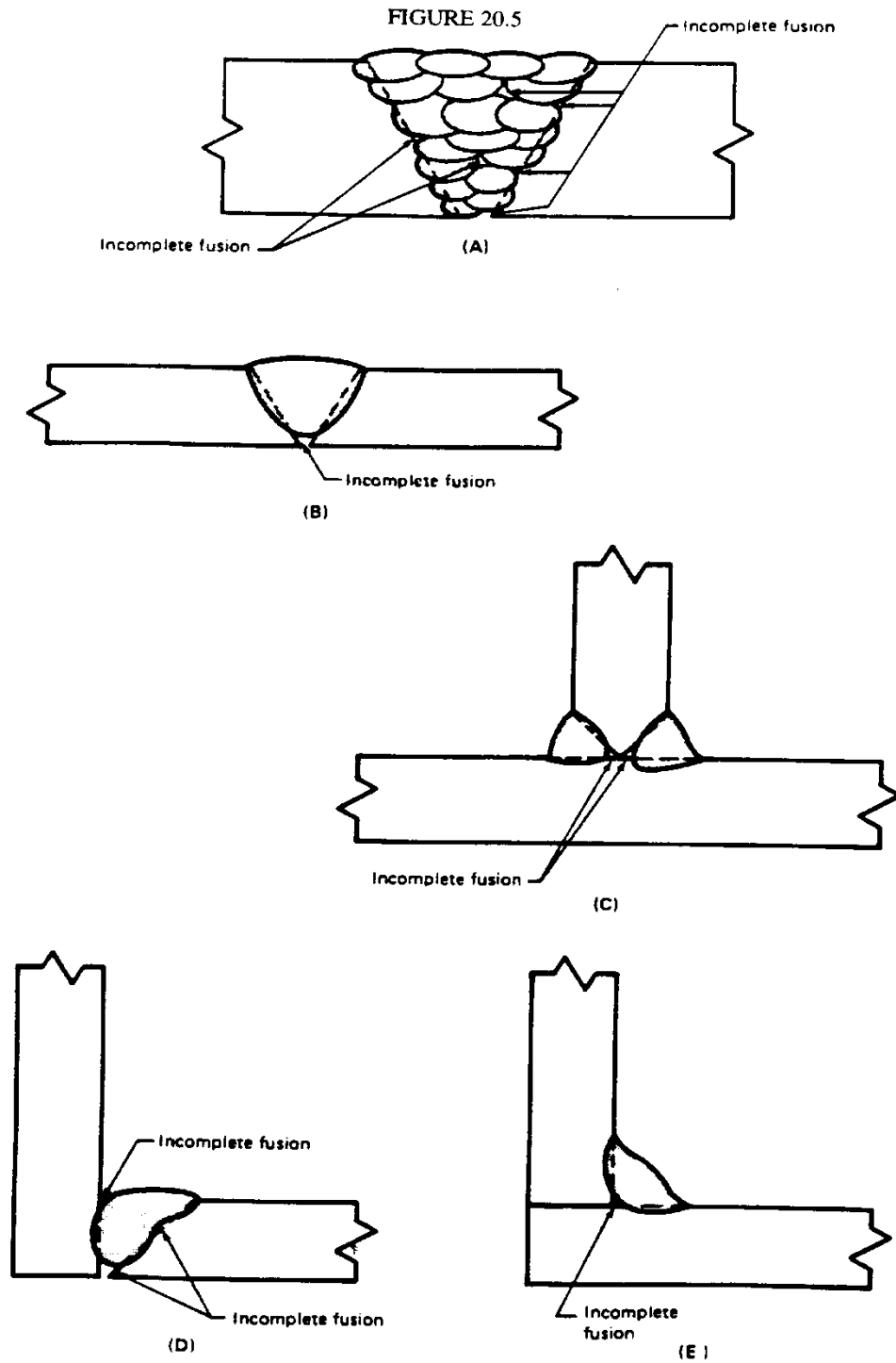
10.2.6.4 Underfill - Is a depression on the face of the weld or root that extends below the surface of the base metal. (See Figures 10.3 & 10.4) (GN24)

FIGURE 10.4



10.2.6.5 Incomplete Fusion - Is a situation where the filler metal has melted but the base metal has not. (See Figure 10.5) (GN24)

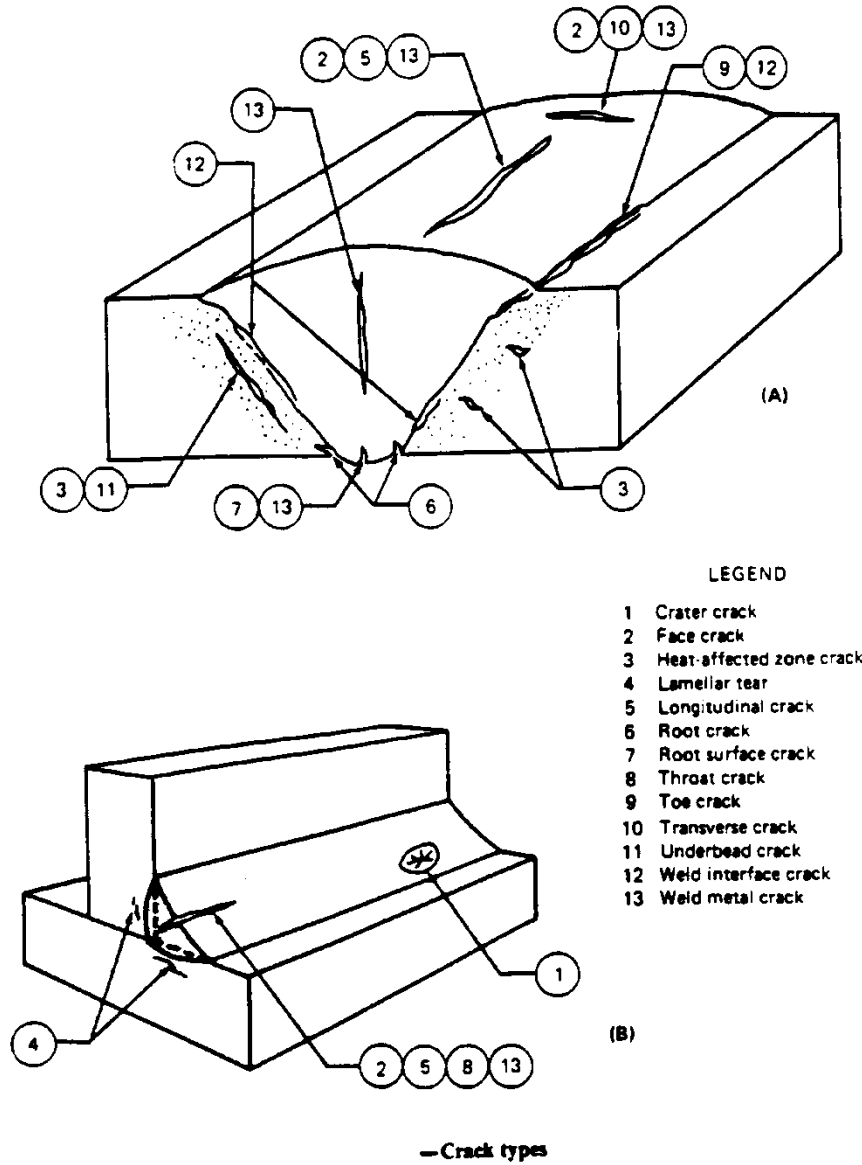
FIGURE 10.5



10.2.6.6 Crater - A depression at the termination of a weld bead. (GN24)

10.2.6.7 Cracks - A parting of clef due to the fracture of solid material. (See Figure 10.6) (GN24)

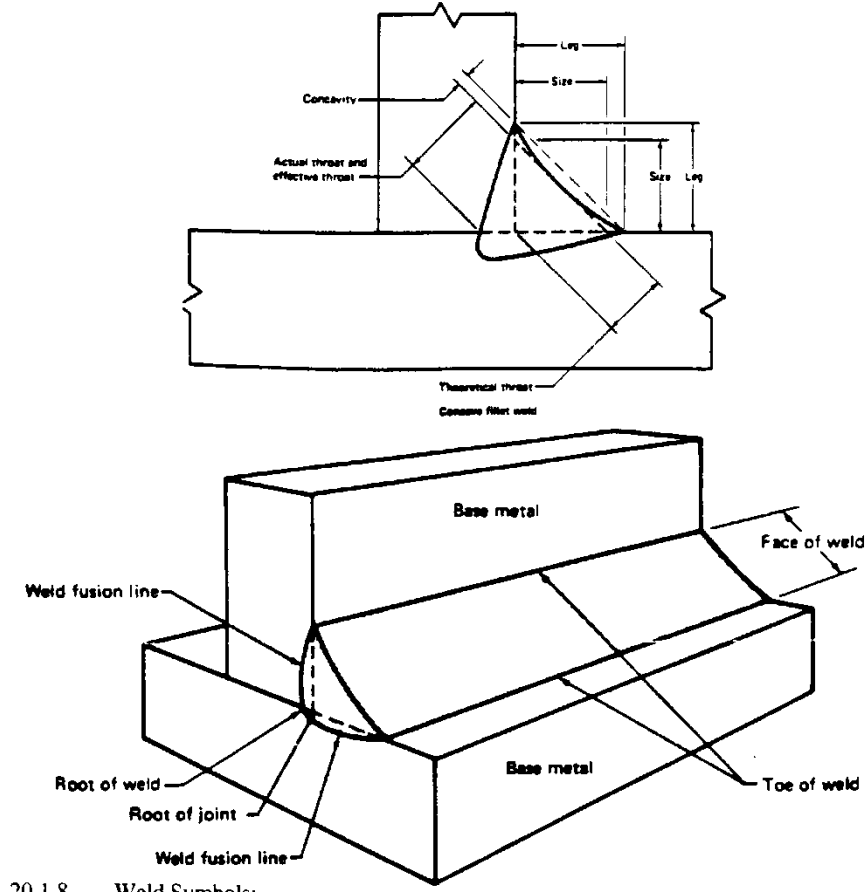
FIGURE 10.6



10.2.6.8 Inclusions - Is foreign solid material trapped in the weld metal. (GN24)

10.2.6.9 Concavity - The maximum distance from the face of a concave fillet weld perpendicular to a line joining the weld toes. (See Figure 10.7) (GN24)

FIGURE 10.7



20.1.2 Weld Symbols

10.3 Weld Symbols

10.3.1 All welding symbols shall be in accordance with ANSI/AWS A2.4 Symbols for Welding. (GN24)

10.4 Spot Welding

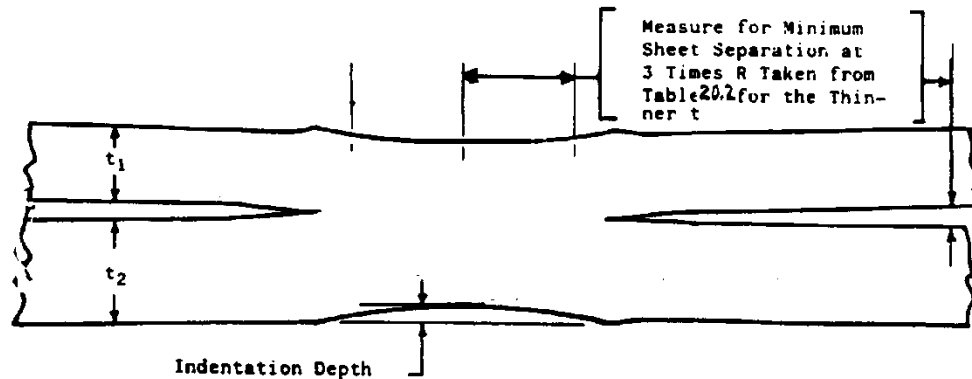
10.4.1 External Imperfections - Welds shall be examined for compliance with the visual criteria defined in 10.4.2 by determining the presence and number of imperfections on all welds. (GN24)

10.4.2 Visual Criteria

10.4.2.1 Sheet separation between an inner and outer member shall not be greater than 0.15 times the combined thickness of the members or 0.006 inch, whichever is greater, measured at a distance (radius) from the nugget center equal to 3 times the radius of the minimum nugget size given in Table 10-2 (Refer Fig 10.8) (GN24)

TABLE 10-2

Nominal Thickness of Thinner Sheet		Nugget Size		Nominal Thickness of Thinner Sheet		Nugget Size	
Inch	(mm)	inch	(mm)	Inch	(mm)	inch	(mm)
0.001	(0.03)	0.010	(0.25)	0.036	(0.90)	0.150	(3.81)
0.002	(0.05)	0.015	(0.38)	0.040	(1.00)	0.160	(4.06)
0.003	(0.08)	0.020	(0.50)	0.045	(1.10)	0.170	(4.32)
0.004	(0.10)	0.030	(0.76)	0.050	(1.20)	0.180	(4.57)
0.005	(0.12)	0.035	(0.89)	0.056	(1.40)	0.190	(4.82)
0.006	(0.16)	0.040	(1.02)	0.063	(1.60)	0.200	(5.08)
0.007	(0.18)	0.045	(1.14)	0.071	(1.80)	0.210	(5.33)
0.008	(0.20)	0.050	(1.27)	0.080	(2.00)	0.225	(5.72)
0.010	(0.25)	0.060	(1.52)	0.090	(2.30)	0.240	(6.10)
0.012	(0.30)	0.070	(1.78)	0.100	(2.50)	0.250	(6.35)
0.016	(0.40)	0.085	(2.16)	0.112	(2.80)	0.260	(6.60)
0.018	(0.45)	0.090	(2.29)	0.125	(3.20)	0.280	(7.11)
0.020	(0.50)	0.100	(2.54)	0.140	(3.60)	0.300	(7.62)
0.022	(0.55)	0.105	(2.68)	0.160	(4.10)	0.320	(8.13)
0.025	(0.65)	0.120	(3.05)	0.180	(4.60)	0.340	(8.64)
0.028	(0.70)	0.130	(3.30)	0.190	(4.80)	0.350	(8.90)
0.032	(0.80)	0.140	(3.56)				

FIGURE 10.8**FIGURE 20.11**

10.4.2.2 Surface Indentation - Excessive indentation is not acceptable on production work if it exceeds:

- a. Sheet; Class A and B: $0.10 t$ or 0.005 inch (0.13 mm); whichever is greater. (GN24)
- b. Sheet; Class C: $0.20 t$ or 0.005 inch (0.13 mm); whichever is greater. (GN24)
- c. But when aerodynamic smoothness is a requirement, the outside indentation shall not exceed 0.004 inch (0.10 mm) on sheet. (GN24)

10.4.2.3 Acceptance Factor: Certain other imperfections are limited in quantity by Table 10-3. The number of visible imperfections shall be calculated by multiplying the factor shown in Table 10-3 times the number of welds inspected and raising the product to the next highest whole number. Parts or lots with imperfections exceeding the quantity as determined from Table 10-3 shall be rejectable. Cracks open to the surface on seam welds shall be rejected. (GN24)

TABLE 10-3 VISIBLE EXTERNAL IMPERFECTIONS FOR PRODUCTION PARTS.

NATURE OF WELD IMPERFECTIONS	ACCEPTANCE FACTOR (SEE 20.2.2.3)		
	Class A	Class B	Class C
Cracks open to surface	.00	.00	.05
Edge bulge cracks	.00	.00	.10
Surface pits over 0.03 inch (1.60 mm) dia.	.00	.00	.10
Surface pits under 0.063 inch (1.60 mm) dia.	.03	.05	.10
Flash and surface fusion	.03	.05	.10

10.4.2.4 Sum of Imperfections: - The sum of all these imperfections shall not exceed 0.10 of the sample in Class A parts, 0.15 in Class B parts, and 0.20 in Class C parts. The imperfections shall be randomly distributed and not clustered in one area, in one part, or in a group of parts. (GN24)

11.0 INSPECTION OF FINISHES – VISUAL AND DIMENSIONAL INSPECTION REQUIREMENTS

11.1 General Requirements

All visual and dimensional inspections performed on material or product manufactured by or purchased for use in the Lansdale facility shall be in accordance with the requirements of this product acceptance procedure.

11.2 Passivation Inspection

- 11.2.1 Visual Examination - Using 5X magnification maximum, the passivated parts shall exhibit a chemically clean surface and shall show no etching, pitting, or frosting that can be attributed to the passivating of the material. (FF18)
- 11.2.2 Sample Size – Shall be in accordance with the TipQA InProcess Inspection instructions.
- 11.2.3 The Inspector shall insure that a Certificate of Conformance is received with each lot of material. (DC18)
- 11.2.4 High Humidity Testing shall be performed, if specified in the TipQA InProcess Inspection instructions for the part number. Testing shall be performed on a one piece sample to the Practice B – High Humidity Test specified in ASTM A967-01. The sample shall be cleaned by immersion in acetone or methyl alcohol or by swabbing with a clean gauze saturated with acetone or methyl alcohol, and dried in an inert atmosphere or desiccated container. The cleaned and dried part shall be subjected on 97 +/- 3% humidity at 100 +/- 5 degrees F for a minimum of 24 hours. The tested sample shall not exhibit rust or staining attributable to the presence of free iron particles imbedded in the surface.

11.3 Chem Film (Chromate Conversion Coating) Inspection

- 11.3.1 Visual Examination (5X magnification)
 - 11.3.1.1 The conversion coating shall be as uniform in appearance as practical. (FF07)
 - 11.3.1.2 It shall be continuous and free from areas of powdery or loose coatings, voids, scratches, flaws and other defects or damages which will reduce the serviceability of parts or be detrimental to the protective value and bonding characteristics. (FF19)

Note: Powdery Areas - A condition of anodized or chemical film coatings exhibiting a dull appearance and loose adherence to the base aluminum.

- 11.3.1.3 The size and number of contact marks shall be at a minimum, consistent with good practice. (FF04)
 - 11.3.1.4 The color of the coating shall range from clear to iridescent yellow or brown. Uniformity color will vary from alloy to alloy on aluminum welds and castings. Areas of rework may not exhibit this uniformity due to touch-up and is not rejectable. (FF02)
 - 11.3.1.5 Clear (colorless) coating shall only be used when specifically authorized by the assembly drawing or purchase order. (FF01)
- 11.3.2 Sample Size – Shall be in accordance with the TipQA InProcess Inspection instructions.
- 11.3.3 The Inspector shall insure that a Certificate of Conformance is received with each lot of material. Confirm class callout referenced, as required. (DC18)
- 11.3.4 Salt Spray Testing shall be performed, if specified in the TipQA InProcess Inspection instructions for the part number. Testing shall be performed on the

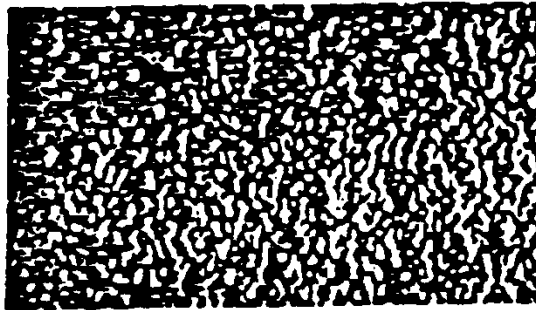
sample specified in the TipQA instruction to the Salt Spray (corrosion resistance) testing specified in MIL-C-5541.

- 11.3.5 Adhesion Testing shall be performed, if specified in the TipQA InProcess Inspection instructions for the part number. Testing shall be performed on the sample specified in the TipQA instruction to the Wet Tape Adhesion test specified in MIL-C-5541.

11.4 Paint Inspection

- 11.4.1 Visual Examination – The painted parts shall be visually inspected for color, gloss, proper masking and workmanship in accordance with the following criteria when viewed at approximately two (2) feet:

- 11.4.1.1 The appropriate paint chip shall be used as a guide while inspecting parts and viewed with the unaided eye. The Inspector shall verify that the color and gloss are as specified using FED-STD-595. Marring, orientation and illumination variations may effect the visual color matching process. If the Inspector is uncertain, the Process Engineer or the Quality Engineer shall be contacted for resolution. (FF02)
- 11.4.1.2 The base coat shall not be visible. Any condition that exposes base material is not acceptable. (FF05)
- 11.4.1.3 No evidence of an orange peel condition, i.e., an irregularity textured in the surface of a paint film. Orange peel occurs as an uneven or grainy surface to the eye, but usually feels smooth to the touch; appearance resembles the skin on an orange. (FF16)



ORANGE PEEL

- 11.4.1.4 No runs or sags, i.e. a flow of excess paint. (FF07)



SAGS OR RUNS

- 11.4.1.5 No wrinkling of the paint, i.e. a surface condition of excessively thick paint causing a wrinkling effect. (FF07)

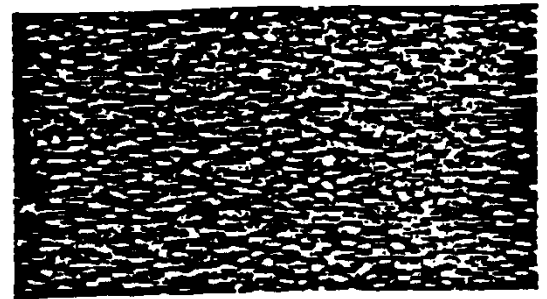


WRINKLING

- 11.4.1.6 No evidence of crazing, checking or cracking. These defects are lines which appear in the paint film. They may be straight or crooked, long or short, interconnected or completely separate. Crazing and checking are surface effects, while cracks penetrate through the film. Checks often take the form of straight lines, while crazing may form a maze of interconnected wavy lines. (FF13)



CRACKING



Micro-Checking

- 11.4.1.7 No evidence of blistering, i.e., a hollow raised spot/bubble on the surface. These blisters are not adherent to the base metal. (FF11)
- 11.4.1.8 No evidence of peeling, flaking and chipping. These conditions are identified by actual detachment of pieces of paint from lower surfaces. (FF12)
- 11.4.1.9 No evidence of pinholes, i.e., pits or depressions which expose base metal or primer surface. This condition does not apply to the painting of radomes. (FF08)
- 11.4.1.10 No evidence of scratches or gouges, i.e., marks on the surface exposing primer and/or base metal. (FF14)

- 11.4.1.11 No evidence of scruff marks, i.e. a difference in the tone or shade of the paint caused by rubbing. (FF10)
 - 11.4.1.12 Incomplete cure, evidenced by a soft, tacky or liquid condition, is unacceptable. (FF20)
 - 11.4.1.13 Clearance holes for fasteners, hardware, and mating of parts normally shall not be painted, but may have evidence of paint to the extent that will not interfere with correct assembly. (FF06)
 - 11.4.1.14 The completed assembly shall be clean of all contaminants, such as lubricating oils, corrosive products, solder fluxes, metal chips, loose/splattered solder, clippings, etc., or any foreign material that could loosen or become dislodged. (FF09)
 - 11.4.1.15 Touchup area(s) may have a slight color shade variation when viewed at approximately 3 feet from the surface, provided that touchup paint color complies with the original paint color requirements. (FF02)
- 11.4.2 Sample Size – Shall be in accordance with the TipQA InProcess Inspection instructions.
- 11.4.3 Thickness of Paint and Primer
- 11.4.3.1 When a drawing states a paint thickness requirement, it shall be confirmed on a one piece sample basis, using a test coupon. The test coupon shall contain the primer and the paint sample. The test coupon shall contain the following information, as a minimum: (FF03)
 - (a) work order number,
 - (b) assembly drawing number,
 - (c) RMS number of the paint and primer,
 - (d) batch numbers,
 - (e) color numbers,
 - (f) gloss range,
 - (g) the thickness requirements for the primer and the actual primer thickness measurement,
 - (h) the thickness requirements for the paint and the actual paint thickness measurement.
- 11.4.4 Paint Adhesion
- 11.4.4.1 When required, by the drawing, work instruction, work order or TipQA InProcess Inspection instruction, paint adhesion shall be done on paint chips using 3M 250 tape. Press a 2-inch length of the 250 tape on the surface of the specimen and remove all air bubbles under the tape. After the tape has been normalized for 10 seconds, rapidly pull the tape back upon itself at approximately 180 degrees. Observe the tested surface for areas where the paint is removed, disregarding flecks of paint on the tape where the underlying metal, chromate, or primer coating is not exposed. (FF12)

11.5 Plating Inspection

- 11.5.1 Visual Examination - Using 10X magnification max., plated parts shall be uniform, smooth, fine grained, adherent and free of exposed base metal, blisters, pits, nodules, voids, and other defects as described below which could be detrimental to their utilization. (See Figure 11.1) The size and number of contact marks shall be at a minimum consistent with good practice, and shall not be rejectable.

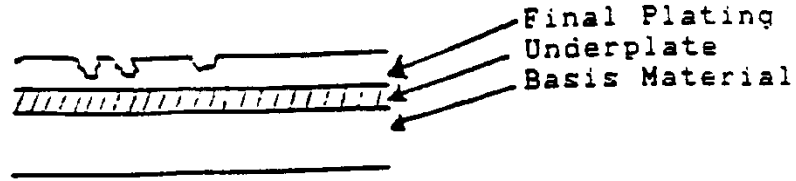
Note 1: Internal threads shall always be masked for plating unless specified otherwise on the drawing.

Note 2: The Inspector shall pay particular attention to the assembly drawing notes for “No plating in threaded holes.”

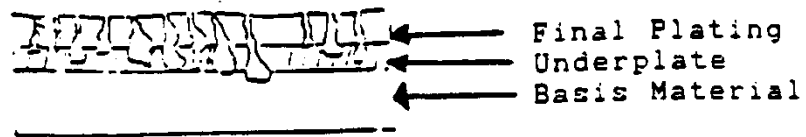
- Pits - Pits are small holes located randomly in the plating, not exposing base metal or underplate. (See Figure 11.1) (FF07)
- Porosity - Similar to pits, except that there are minute holes (these holes are not normally visible) allowing the passage of liquids to underplate or basis material. Where the condition becomes severe enough to be visually evident, the holes are defined as voids. (See figure 11.1) (FF05)
- Voids - The absence of plating on a specific area. (See Figure 11.1) (FF04)
- Nodules - Small or large mass of rounded or irregular-shaped lumps, bumps, or peaks. (See Figure 11.1) (FF07)
- Burned Areas - Areas of plating that show considerable discoloration or roughness due to excessive current during plating. (FF10)
- Blisters - A lifting of plating in a small area (appearing as a small bubble or bubbles), a blister will not be adherent to the basic material and/or underplate when subjected to test. (FF11)
- Scratches - Lines/breaks in plated or chemical film surfaces that expose the base material or underplate. (FF14)
- Excessive build-up of plating - A condition where the thickness of the plating is excessive in certain areas such as: around holes, inside holes, along the edges and surfaces, etc., of the basis material. (FF03)
- Rough Plating - A condition where the plating is not continuous, smooth and fine grained. (FF07)
- Peeling or Lifting of Plating - A condition where the plating separates from the underplate and/or basis material, exposing the underplate and/or the basis material. The plating is not adherent to underplate and/or the basis material when subjected to adhesion testing. (FF12)
- Smutty Areas - A condition where the coating has a dull appearance and can be removed by rubbing with a kim-wipe or doe-pac. (FF10)

FIGURE 11.1**PLATING INSPECTION VISUAL AIDS**

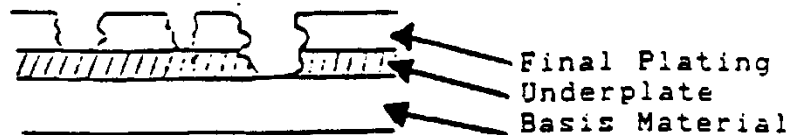
PITS - Pits are holes in plating not exposing the basis material or underplate.



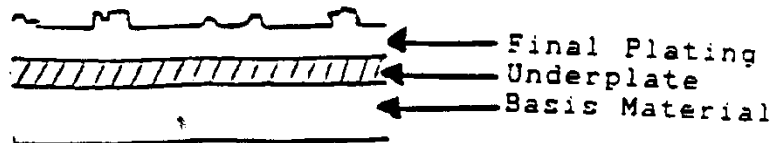
POROSITY - Similar to that of pits, except in completeness (full of holes or pores) and not exposing the basis material or underplate.



VOIDS - A hole in the plating that exposes the basis material or underplate.



NODULES - Small or large mass of round or irregular shaped bumps, lumps or peaks.



- 11.5.2 Sample size – For visual inspection purposes, the sample size shall be in accordance with the TipQA InProcess Inspection instructions.
- 11.5.3 Dimensional Inspection – Post plating dimensional inspection shall be performed as follows:
- 11.5.3.1 The sample size shall be in accordance with the TipQA InProcess inspection instructions.
- 11.5.3.2 The Inspector shall perform the following dimensional inspections:
- (a) Holes - Verify hole sizes are maintained by checking a minimum of 10% of holes on each sample part.
 - (b) Threads - Verify thread sizes are maintained, by inspecting a minimum of 10% of threads on each sample part.
 - (c) Dimensional - Verify critical dimensions, i.e. those that have tolerances tighter than that specified in the drawing tolerance block and verify outline dimensions are maintained i.e., outside diameter., length, height, width and features such as slots and pockets. It is not necessary to check hole to hole, feature to feature or surface to surface dimensions.
- 11.5.4 Thickness Measurement
- 11.5.4.1 Thickness measurements shall not be performed when the supplier has provided us with the required Fisherscope thickness measurements and no dimensional inspection issues were discovered by Lansdale Inspection. In the event, thickness measurements are required; they shall be performed in accordance with 1611694. Thickness of plating shall be an average of a minimum of three (3) readings. Min/Max requirements shall not be exceeded at any one point. (FF03)

12.0 INSPECTION OF MARKING – VISUAL INSPECTION REQUIREMENTS**12.1 General Requirements**

All visual and dimensional inspections performed on material or product manufactured by or purchased for use in the Lansdale facility shall be in accordance with the requirements of this product acceptance procedure.

12.2 Visual Examination - The hardware marking shall be in accordance with the method specified on the drawing. All hardware shall meet the following marking requirements in addition to any marking requirements specified on the drawing.

12.2.1 The content shall be as specified on the drawing. If the drawing does not specify the content, then the hardware shall be marked in accordance with the applicable military standard, if a mil part, or the supplier's standard marking. (MA02)

12.2.2 Unless dimensionally specified on the drawing, the marking shall be "approximately as shown." This allows the marking to be within the general area and not exactly at the location on the drawing pictorials, provided it does not interfere with or is not obscured by other features. Marking shall be properly aligned and registered. (MA03)

Rules governing "Approximately as shown" are:

(a) The characters shall be within the quadrant of the part shown in the drawing/pictorial.

(b) The characters shall be in the same relative position to other features on the drawing pictorial.

12.2.3 Marking shall be sharp, well defined and easily readable. Blurring, smearing, or other imperfections that impair the legibility shall be unacceptable. No characters shall be missing in whole or in part. (MA01)

12.2.4 When labels are required for marking purposes, there shall be no evidence of peeling of the label from the surface of the hardware. Misplaced or overlapping labels are rejectable. (MA05)

13.0 INSPECTION OF MECHANICAL FASTENERS/HARDWARE – VISUAL AND DIMENSIONAL INSPECTION REQUIREMENTS

13.1 General Requirements

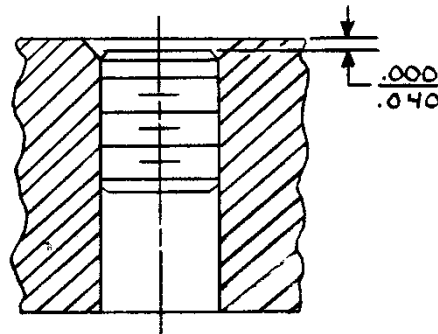
All visual and dimensional inspections performed on material or product manufactured by or purchased for use in the Lansdale facility shall be in accordance with the requirements of this product acceptance procedure.

- 13.2 **Definition** - Into the barrel/shank/spindle: a characteristic of a through-hole fastener extending into the hole beyond the surface of the material directly surrounding the fastener.

13.3 Screw Inserts

- 13.3.1 Unless specifically delineated on drawing, threaded inserts shall be inserted to the depth shown in Figure 13.1. (HA08) The insert shall show no signs of cracks, missing nylock, or show damage after installation. (HA07). The piece part shall not be burred or show evidence of plating damage due to tooling used for installation. . (HA07, FF10)

FIGURE 13.1



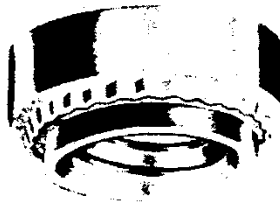
13.4 Clinch Nuts and Studs

- 13.4.1 Must be tight and perpendicular to within 2 degrees to the mounting surface and shall not be loosened by the accompanying screw or nut . (HA04, HA08).
- 13.4.2 Clinch hardware shall be centrally pressed in mating hole with no visible light showing around entire circumference. (HA08).
- 13.4.3 Unless otherwise specified, the clinch nut or stud shall be installed after plating. (HA08).
- 13.4.4 Studs to be flush within + 0.005/-0.002 of surface. (HA08). (The following figures depict Mil-Spec installation requirements. (HA08). Refer to Mfg. Instructions on inserts other than that shown). (HA08).
- 13.4.5 Material Displacement - Material bulge shall be allowed when design requirements are such that clinch nuts are positioned near an edge. (HA08). The bulge shall not extend beyond the detail tolerance. (HA08). Precautions are to be made to minimize deformity and assure installation meets requirements described above. (HA08).

13.5 Clinch Nuts, Plain Round

- 13.5.1 Clinching ring to be totally imbedded around the entire circumference. (HA08). The shoulder shall contact the structure for a full 360 degrees, but shall have no part of the shoulder imbedded in the structure. (HA08). The bottom of the shank shall not protrude from the underside of the structure. (HA08).
(See Figure 13.2)

FIGURE 13.2



Configuration: Plain Round
(Ref. MIL-N-45938/1)

13.6 Clinch Nuts, Knurled Collar

- 13.6.1 Clinch nut (reference Figure 13.4 to be pressed in to cause a 0.015 inch minimum penetration into the structure for a full 360 degrees. (See Figure 13.3). (HA08).

FIGURE 13.3

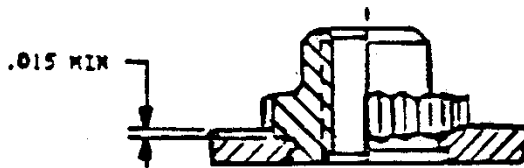
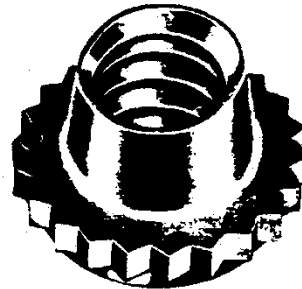


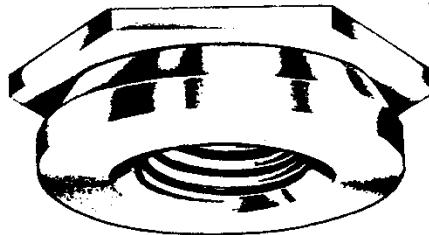
FIGURE 13.4



Configuration: Knurled Round
(Ref. MIL-N-45938/3)

13.7 Clinched Nuts, Flush

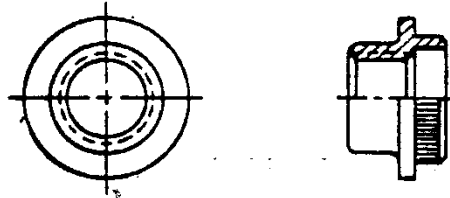
- 13.7.1 Hexagonal head to be pressed in flush with structure surface. (HA08). On hex side, flush to 0.005" above is permitted unless specifically called out on drawing. (Reference Figure 13.5) (HA08).

FIGURE 13.5

Configuration: Flush
(Ref. MIL-N-45938/4)

13.8 Clinched Nuts, Swage, Clinching

- 13.8.1 Clinch nut to be pressed until the shoulder of the nut contacts the structure for a full 360 degrees. (HA08). The shank shall be flared 45 degrees, no cracks shall be permitted. (Reference Figure 13.6) (HA08/HA07).

FIGURE 13.6

Configuration: Swage
(Ref. MIL-N-45938/5)

13.9 Floating Fasteners

- 13.9.1 Floating hardware shall float free after installation and finishing. (HA06). Immobilized hardware prevents proper fastener action. (HA08).

13.10 Roll Pins

- 13.10.1 Must be tight and perpendicular within 2 degrees to the mounting surface. (HA08). Care shall be taken to assure pin is not mushroomed or deformed during installation. (HA07). Pin to be pressed flush to 0.005" below. (HA08). Pin shall not protrude opposite driven side. (HA08).

13.11 Helically Coiled Inserts

- 13.11.1 Inserts to be installed to a depth of 3/4 to 1 1/2 pitch (threads) below work surface. (HA08). Tang shall be broken off insert and removed from hole. (Note: 1 pitch = 1 full revolution of thread). (HA08).

- 13.11.2 Tapped holes will be gaged prior to installation of coiled inserts. (HA08). It is not necessary to gage the installed insert.

13.12 **Tubular Eyelets or Fasteners (Non -printed circuit type) (Ref. Figure 13.17)**

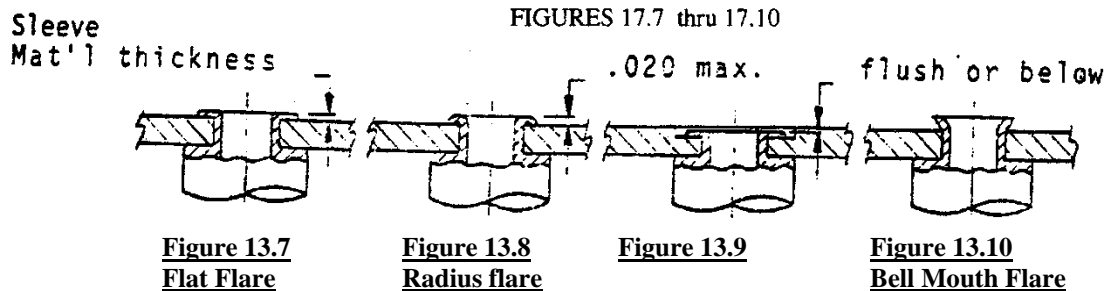
- 13.12.1 Cracks or splits are allowed in the rolled or flared portion provided:
- No more than 3 cracks total. (HA07).
 - No more than 1 crack within a 90-degree quadrant. (HA07).
There shall be a minimum of 90° between cracks. (HA07).
 - Cracks may not extend into the barrel. (HA07).
 - No evidence of missing material is allowed. (HA07).
 - Cracks shall not be concentric to body of fastener. (HA07).

13.13 **Captive Screws**

- 13.13.1 Flare Flatness

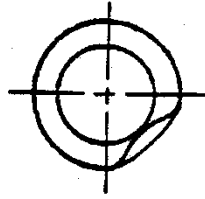
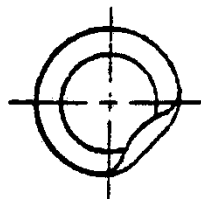
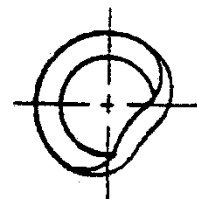
13.13.1.1 Thru Holes/Counterbored Holes

(A) Edges - The flare shall be flattened so the periphery will come in contact with the panel material with no clearance apparent. (HA08). The flaring tool radius on the top of the flare is allowable (See figure 13.7). (HA08). Bell mouth or incomplete flares will reduce the push-out resistance; consequently they are not acceptable (See figure 13.9) (HA08).



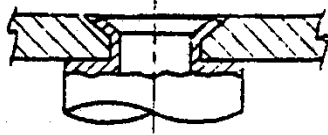
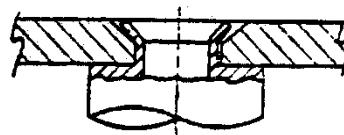
(B) Height - Flare height shall not exceed .020 on radiused flares (See figure 13.8) or should not protrude beyond the prescribed C'Bores. (See Figure 13.9) (HA08).

(C) Folds - One fold thru no more than 90 ° and not entering into the barrel is acceptable unless cosmetic reasons are involved and their height does not protrude beyond the counterbore. (See Figures 13.11, 13.12 and 13.13) (HA08).

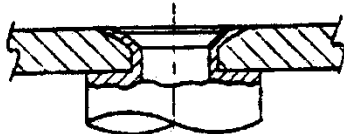
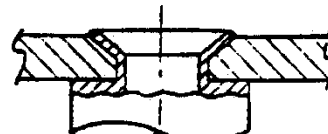
FIGURE 13.11
Acceptable**FIGURE 13.12**
Not Acceptable**FIGURE 13.13**
Not Acceptable

13.13.1.2 C'Sunk Applications:

(A) Edges - The flare edges shall be flat against the panel C'Sink. (HA08). Since hand flaring does not feather the edges out, the sharp edge is allowed.

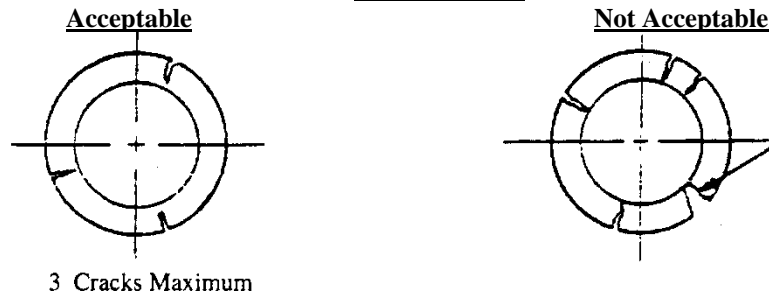
FIGURE 13.14
Acceptable**FIGURE 13.15**
Not Acceptable

(B) Protrusion - The flare shall not protrude from the C'Sink. (HA08). If this occurs, feathering of the edges is permissible. (HA08).

FIGURE 13.16**Acceptable****Not Acceptable**

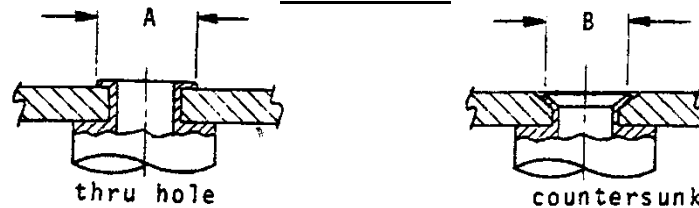
13.13.1.3 Flare Cracks - Flare cracks shall be acceptable if they meet the following criteria (Reference Figure 13.17):

- (a) There is no more than 3 cracks total with no more than any two in the same quadrant. (HA07).
- (b) The cracks do not go into the barrel of the sleeve. (HA07).
- (c) Flare is not rejectable for cosmetic reasons. (HA07).

FIGURE 13.17

Captive screw fastener looseness. Installed captive screw fasteners shall not rotate when normal finger pressure is applied. (HA04).

- 13.13.1.4 Flare Diameter - The minimum flare diameter for through and countersunk holes as shown in Figure 13.18 shall be in accordance with Table 13-1. (HA08).

FIGURE 13.18**TABLE 13-1**

SIZE	A MIN.	B MIN.
4	.218	.208
6	.240	.230
8	.252	.242
10	.288	.278
12	.354	.344

13.14 **Rivets**

- 13.14.1 General - In riveting different thicknesses of materials, the upset head shall be on the side of the thicker material and/or harder material. (DM11).

13.14.2 Cracks

- There shall be no circumferential cracks and not more than one radial crack nor other evidence of fatigue imposed upon the solid, tubular, or semi-tubular rivets. (See Figure 13.19A) (HA07).
- In the case of a driven head, there shall be no circumferential cracks and no more than two radial cracks, which must stop short of the shank area. (See Figure 13.19B) (HA07).
- In terms of overlap with a solid rivet head, heads that are eccentric with the shank must extend beyond the hole at all points. (See Figure 13.19C) (HA08).

FIGURE 13.19A

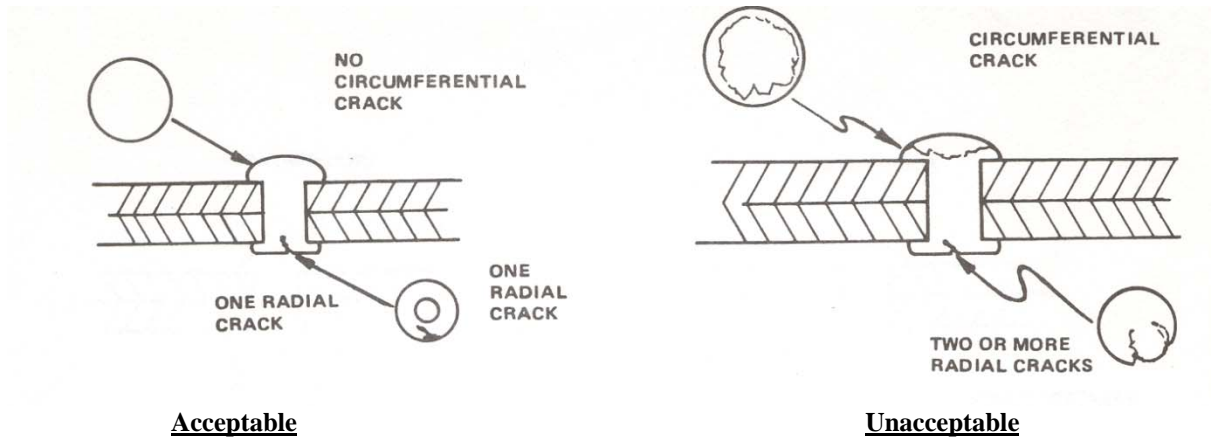


FIGURE 13.19B

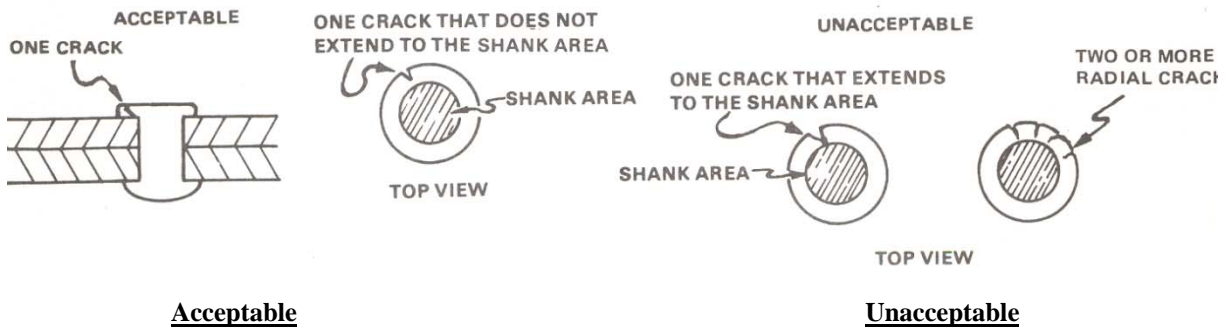
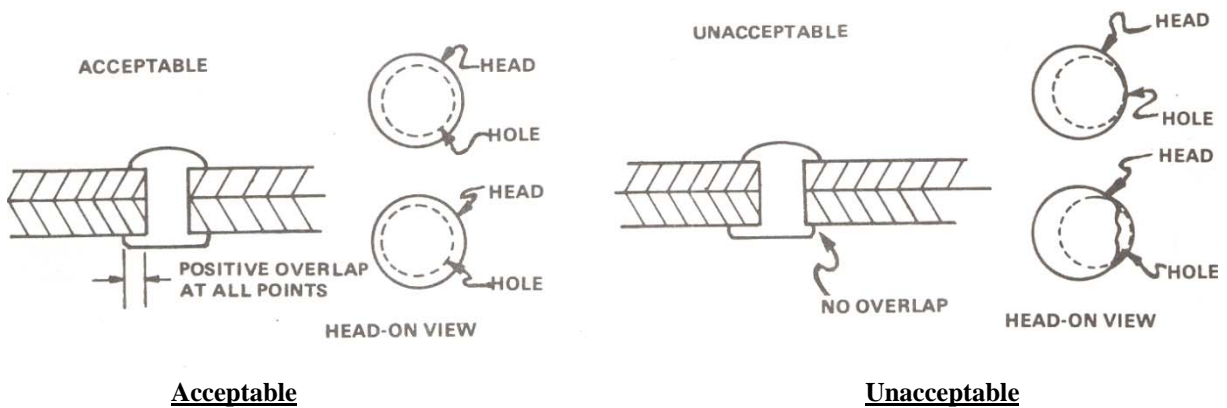


FIGURE 13.19C

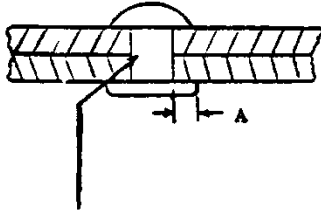


13.14.3

Proper Seating, Head Distortion and Head Diameter and Height Requirements

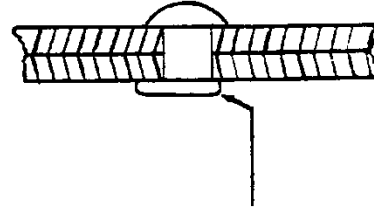
- Rivets shall be driven in such a manner that, after riveting, the joints shall be tight, and the rivets heads shall be properly seated against their

bearing surfaces and meet the distortion and head diameter/height requirements depicted below. (HA08).

ACCEPTABLE

Rivet Diameter

Driven head offset but within the following limits:
 $A \text{ min.} = 0.13 \times \text{rivet diameter}$
 $A \text{ max.} = 0.38 \times \text{rivet diameter}$

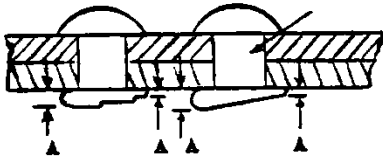
UNACCEPTABLE

Driven Head

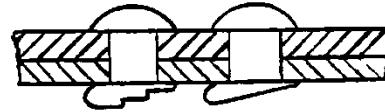
Driven head offset beyond acceptable limits.

ACCEPTABLE

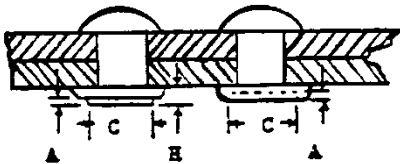
Rivet Diameter



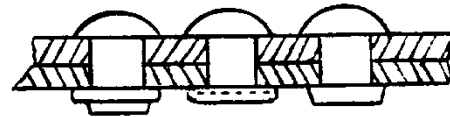
Driven head beveled or stepped but within the following limits:
 $A \text{ min.} = 0.35 \times \text{rivet diameter}$
 $A \text{ max.} = 0.65 \times \text{rivet diameter}$

UNACCEPTABLE

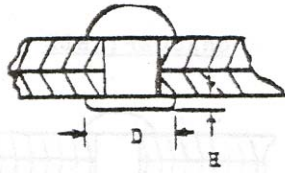
Driven head beveled or stepped in excess of acceptable limits.

ACCEPTABLE

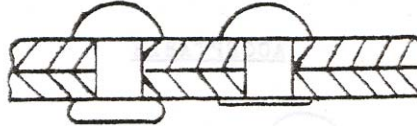
Driven head deformed with punch rings but within the following limits:
 $A \text{ max.} = 0.1H$
 $C \text{ min.} = 1.4 \times \text{rivet diameter}$

UNACCEPTABLE

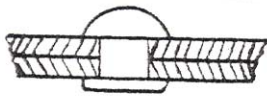
Driven head deformed in excess of acceptable limits.

ACCEPTABLE

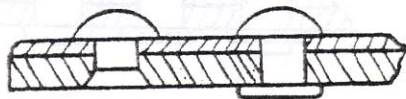
Driven head dimension within the limits specified in Table 17.2.

UNACCEPTABLE

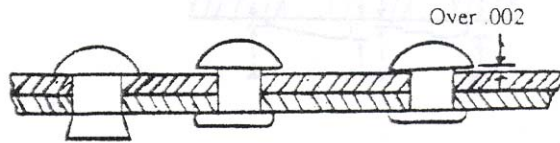
Driven head size in excess of acceptable limits.



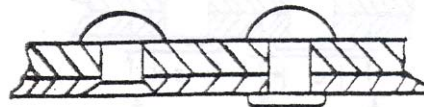
1. Driven head completely drive.
2. Manufactured head tight against riveted surface
3. Manufactured head perpendicular to rivet body.



Driven head formed against thicker panel whenever possible.



1. Bell head.
2. Open head.
3. Tilted head.

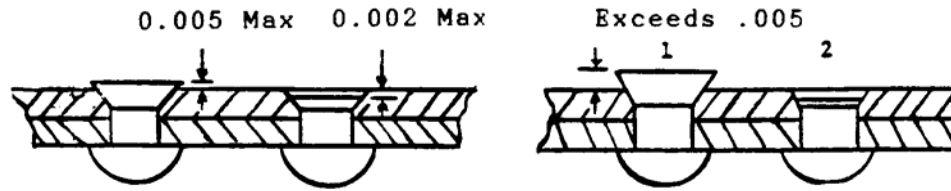


Driven head formed against thinner panel.

TABLE 13-2

		Tolerance of upset rivet head 2017 D Rivets			
SIZE	"D"Max.	"D" Min.	"H" Max.	"H" Min.	
.062	.093	.077	.041	.031	
.093	.140	.125	.062	.047	
.125	.187	.156	.078	.062	
.156	.234	.203	.109	.078	
.187	.281	.234	.125	.093	
		Tolerance of upset rivet head for Rivets other than 2017D			
SIZE	"D"Max.	"D" Min	"H" Max.	"H" Min.	
.062	.103	.077	.041	.020	
.093	.156	.125	.062	.031	
.125	.203	.156	.078	.047	
.156	.264	.203	.109	.051	
.187	.312	.234	.125	.063	

ACCEPTABLEUNACCEPTABLE



Manufactured countersunk head is flush within:

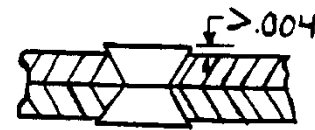
+ 0.005"
- 0.002"

(DM20).

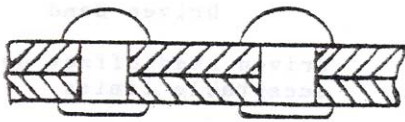
1. Manufactured head above panel caused by long rivet or (DM21).
2. Manufactured head below panel surface due to short rivet being used. (DM21).



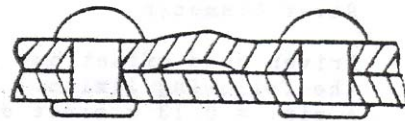
1. Cylindrical portion is at least 0.15 on at least one of the panels. (DM20).
2. Manufactured head shall not exceed .004 beyond the surface. A maximum of 0.006 inch may be shaved from protruding head(DM21).



1. Double countersink with cylindrical portion due countersink too deep(DM20)
2. Driven head not finished after trimming. (DM20)
3. Projection height of countersink head beyond 0.004 inch. (DM20)

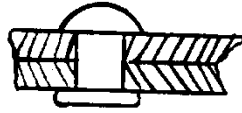


Multiple rivets installed so as to keep sheets straight and parallel.

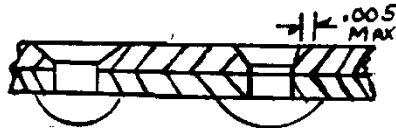


Sheet separation or buckling due to incorrect or out of line holes or cumulative tolerance of the sheets.

ACCEPTABLE



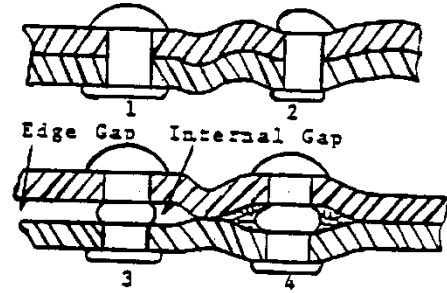
1. Sheets uninjured by tools.
2. Sheets flat.
3. Sheets properly and tightly clamped.
4. Sheets clean prior to rivet installations.



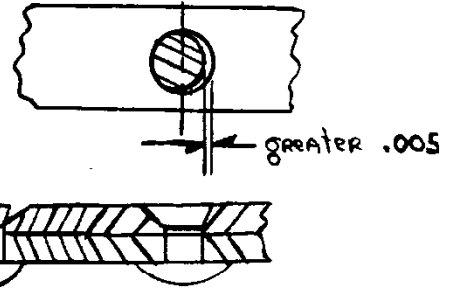
1. Rivet shank completely fills hole. Unless print requirements are such that the combination of countersink diameter and rivet length does not allow material to fill hole. The upset rivet shall be symmetrical to the countersink.
2. Conical portion of driven head fills countersink or dimple provided.
3. Driven head not more than .005 from edge of hole.

ACCEPTABLE

UNACCEPTABLE

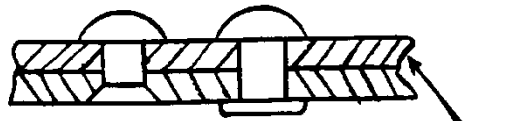


1. Sheets injured by rivet gun or trim-rush shaver.
2. Sheet deformed by excessive pressure.
3. Sheet separation and swelled rivets due to poorly clamped sheets.
4. Sheet separation and swelled rivets due to chip caught between sheets.



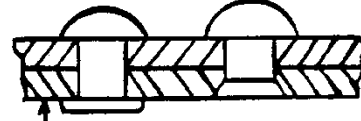
1. Rivet shank does not fill hole in sheet material.
2. Conical portion of driven head does not fill space provided.
3. Less than 50% periphery where driven head touches countersunk hole.

UNACCEPTABLE



Soft or nonmetallic material

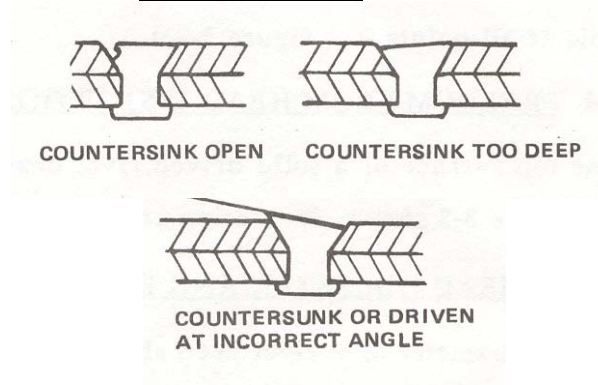
Driven head formed against the harder material of the sheets being joined wherever possible.



Non-metallic

Driven head furnished against soft or Non-metallic panel.

UNACCEPTABLE

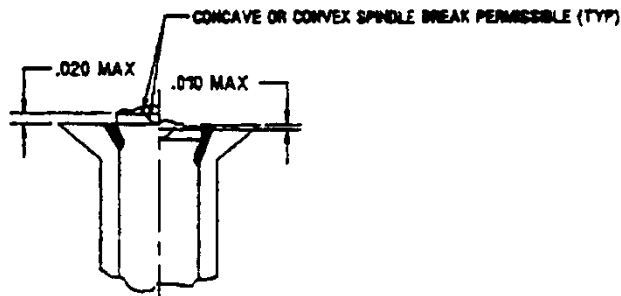


13.14.4

Blind, self-plugging mechanically locked spindle (pop rivet types including cherry rivets).

13.14.4.1 Protrusion of the rivet spindle. The excess protrusion of the rivet spindle shall be removed during the driving operation and shall be flush within the limits shown in Figure 13.20. (HA08).

FIGURE 13.20



SPINDLE LIMITS

SPINDLE SHALL NEVER BE MORE THAN .020 ABOVE TOP OF RIVET HEAD OR MORE THAN .010 BELOW TOP OF RIVET HEAD. THIS APPLIES TO BOTH FLUSH AND PROTRUDING HEAD RIVETS.

13.14.4.2 Collar limits (Reference Figure 13.21 and Table 13-3) Locking collar shall never be more than "B Max" above the top of the rivet head

when the spindle is above the rivet head. If the spindle is flush or below flush with the rivet head, the locking collar shall not be more than "A MAX" above the spindle. (HA08).

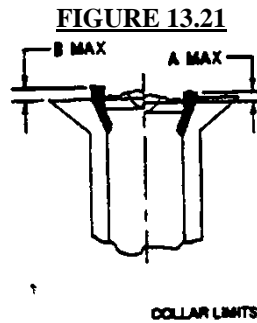


TABLE 13-3

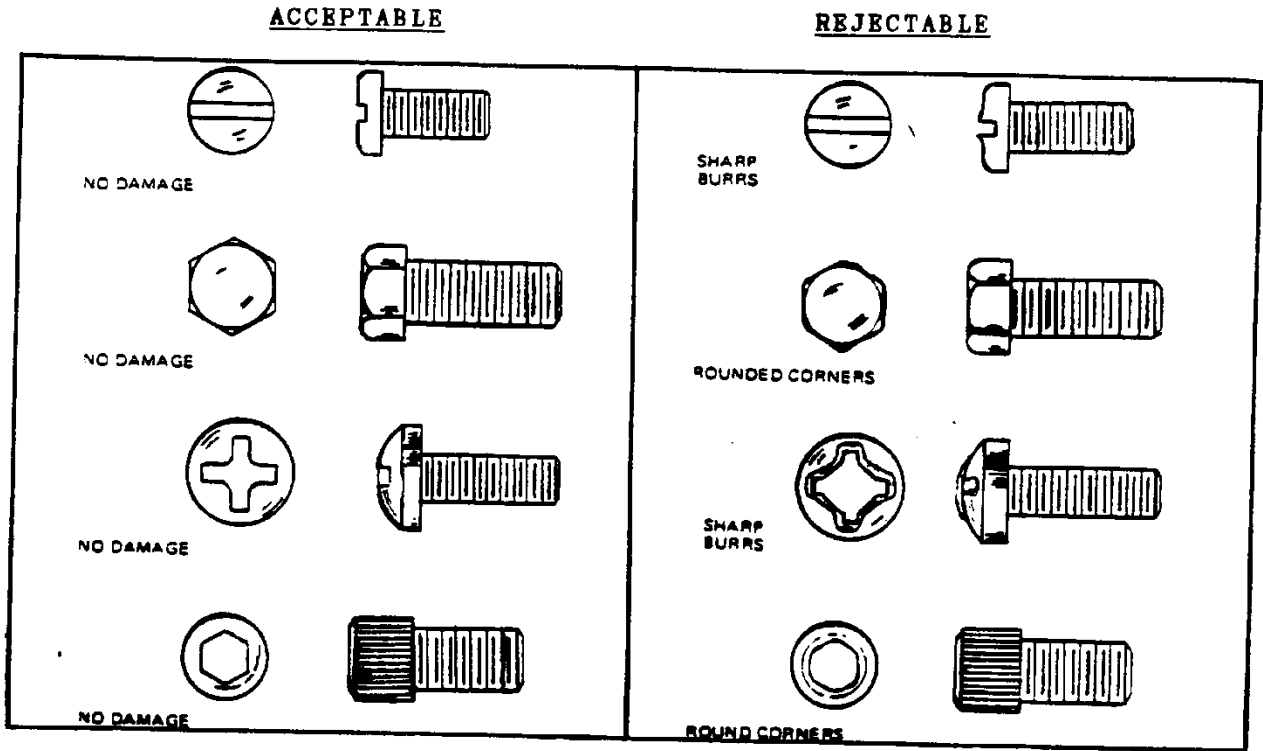
	-3 DIA	-4 DIA	-5 DIA	-6 DIA	-6 DIA
A MAX	.015	.015	.020	.025	.030
B MAX	.010	.010	.010	.015	.020

13.14.4.3 Portions of the spindle and collar of 100° flush-headed rivets may be shaved up to .005 to meet the criteria of 13.14.4.1 and 13.14.4.2. (HA08).

13.15 Hardware Installation – Threaded Fasteners, i.e. Screws, bolts, etc.

- 13.15.1 The product shall meet the latest revision of the visual inspection criteria of IPC-A-610, paragraph 4.2.3, Hardware Installation – Threaded Fasteners in addition to the criteria specified below. (HA08).
- 13.15.2 Thread extensions shall be in accordance with IPC-A-610, paragraph 4.2.3, unless otherwise specified by the assembly drawing. (HA08).
- 13.15.3 The proper hardware installation sequence shall be verified to be in accordance with IPC-A-610, paragraph 4.2.3, unless specified otherwise by the assembly drawing. (HA08). Hardware shall be properly installed. (HA08).
- 13.15.4 When required by the drawing, work instruction or router, fasteners shall be tightened to the specified minimum torque requirements. (HA03).
- 13.15.5 Bolt and screw heads shall not show evidence of burrs or distortion of slots (HA07). or recesses to the extent that removal may be difficult or that sharp edges protrude. (HA08). Crossed or striped threads shall not be acceptable. (HA07). See Figure 13.A.

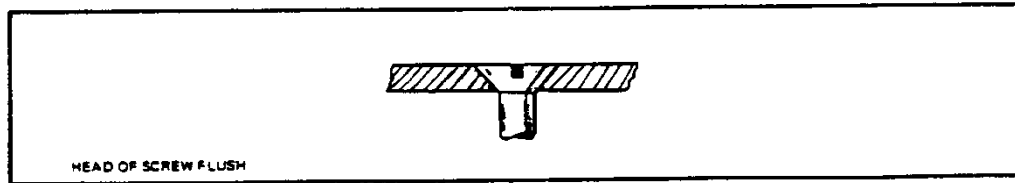
FIGURE 13.A



13.15.6


The heads of flat head screws shall be flush to or slightly below the adjacent surface. Reference Figures 13.B, 13.C and 13.D for acceptance and reject criteria. (HA08).

Figure 13.B (ACCEPTABLE)



Head of screw flush to + .005" (HA08).

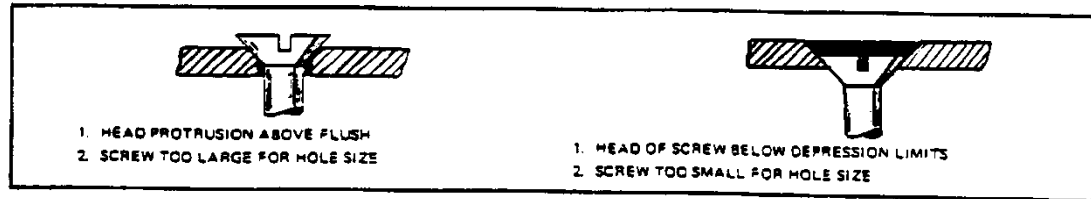
Figure 13.C (ACCEPTABLE)



HEAD DEPRESSION WITHIN LIMITS LISTED

THREAD SIZE	4	6	8	10	0.250 & UP
MAX DEPRESSION	0.015	0.020	0.025	0.030	0.040

Figure 13.D (REJECTABLE)



13.15.7 When a flat washer is required, it shall cover the slot or hole in accordance with IPC-A-610, paragraph 4.2.3. (HA08).

13.15.8 Nuts shall show no obvious evidence of damaged or rounded edges beyond normal installation and testing processes. (HA07).

13.16 Retaining Rings

13.16.1 Retaining rings shall be properly seated in its groove. (HA08). There shall be no evidence of cracks or fractures. (HA07).

13.17 Gaskets

13.17.1 Gaskets shall be properly located, having no gaps where ends meet, tightly cemented, no damage, no excessive adhesive or sealant. (BC04, BC06).

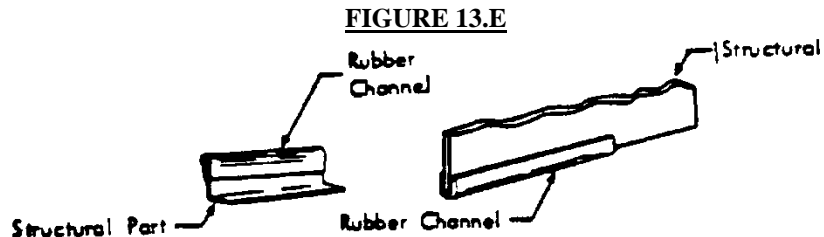
13.7.2 Gaskets shall be installed in such a manner as not to detract from the operations, function, or appearance (where a factor) of the equipment. (BC06).

13.18 Grommet

13.18.1 Ensure that the grommets are seated or installed properly and are not loose. (BC06).

13.19 Rubber Channel

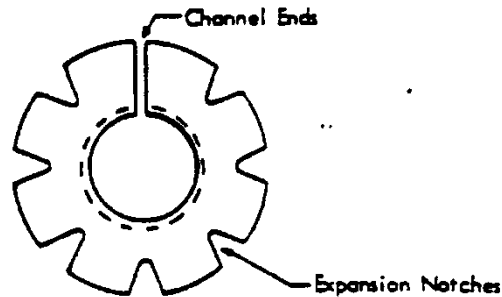
13.19.1 Rubber channels to protect wiring from sharp edges on structural parts shall be cemented tightly to the structural part with cement running the entire length of the channel. (BC06). The channel shall be long enough to provide protection for wiring wherever it may be moved. (HA08). The ends of the channel shall not hang over the structural part. (HA08). The ends shall be cut neatly and squarely. (See Figure 13.E) (HA08).



13.20 Rubber Channels for Grommets

- 13.20.1 The channels shall have expansion notches equal in size and spacing. (HA08). The ends of the channel shall not be more than 1/16 inch apart when the channel is seated in a hole in the structural part. (HA08). The ends of the channel shall be cut neatly and squarely. (HA08). No cement is required. (See Figure 13.F) (HA08).

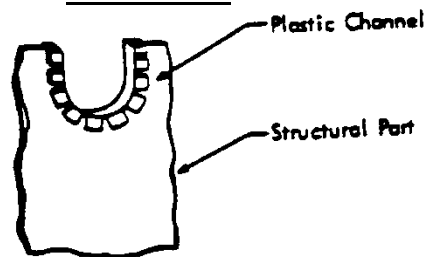
FIGURE 13.F



13.21 Plastic Channels

- 13.21.1 Plastic channels used to protect wiring from sharp edges on structural parts shall be cemented tightly to the structural part with cement running entire length of the channel. (BC06). The channel shall be long enough to provide protection for the wiring wherever it may be moved. (HA08). The ends of the channel shall not hang over the structural part and shall be cut neatly and squarely with no sharp edges or corners. (See Figure 13.G) (HA08).

FIGURE 13.G



NOTE: Flatness requirements per Section 9.0 Sheet Metal must be maintained

13.22 Torque Verification

All operators performing a torquing function shall be certified in accordance with company procedures in order to assure that the hardware has been adequately torqued. (HA03).

14.0 INSPECTION OF CABLE AND WIRE HARNESS ASSEMBLIES – VISUAL AND DIMENSIONAL INSPECTION REQUIREMENTS**14.1 General Requirements**

All visual and dimensional inspections performed on material or product manufactured by or purchased for use in the Lansdale facility shall be in accordance with the requirements of this product acceptance procedure.

14.2 Use of IPC/WHMA-A-620

All inspections performed on cables and wire harness assemblies that are purchased or manufactured in the Lansdale facility shall be in accordance with the requirements of this product acceptance procedure and IPC/WHMA-A-620. The User of this product acceptance procedure shall refer to the applicable section of the IPC standard whenever the quality of the product does not meet the requirements specified herein. The IPC standard provides additional guidance regarding the quality acceptance requirements depending upon the nature of the defect. When the additional guidance indicates that the condition is acceptable, the User shall accept the product. Any condition identified as a Process Indicator or a Defect condition shall be rejected.

Access to the latest revision of IPC/WHMA-A-620 can be obtained as follows:

- (1) Access the SASL Sharepoint Site
- (2) Click on Applications on the left hand side of the screen.
- (3) Click on HIS – Specs and Standards
- (4) Click on the “IHS Standards Expert” link.
- (5) When the Security Alert box appears, click on the YES button.
- (6) Enter the document number in the Search block entitled Document Number or Organization and click on the “Search” button
- (7) Click on the “View” link to open the document that you are searching for.

14.2.1 Training/Certification

All personnel inspecting and accepting hardware to the inspection criteria of Section 14.0 of this standard and IPC/WHMA-A-620 must be trained and certified by the Lansdale Mission Success and Product Assurance department.

14.3 Preparation of Wires (Ref. Section 3 of IPC/WHMA-A-620)

- 14.3.1 **Strand Damage** – Strands are not scraped, nicked, severed or otherwise damaged. (WB04)
- 14.3.2 **Conductor Deformation** – Strands are not flattened, untwisted, buckled, kinked or otherwise deformed. (WB17)
- 14.3.3 **Wire Separation** – No birdcaging. (WB17)
- 14.3.4 **Damaged Insulation** – Insulation has been trimmed neatly with no signs of pinching, pulling, fraying, discoloration, charring or burning. (WB04)

14.4 **Soldered Terminations (Ref. Section 4 of IPC/WHMA-A-620)**

- 14.4.1 **Cleanliness** – No presence of flux residues or particulate matter. (SD17)
- 14.4.2 **Insulation Clearance** – There is an insulation clearance of one diameter between the end of the insulation and the top of the solder fillet. (WB01)
- 14.4.3 **Insulation Damage from Soldering** – Insulation is not melted, charred or otherwise damaged from the soldering process. (WB04)
- 14.4.4 **Flexible Sleeve Insulation** – Insulation sleeving overlaps the connector terminal and extends over the wire insulation four wire diameters. Insulation sleeving is one wire diameter for the point where the connector terminal enters the connector insert. (WB01)
- 14.4.5 **Birdcaged Wire (Soldered)** – No birdcaging. (WB17)
- 14.4.6 **Connection Reqts – Turret terminals**
 - a. Wraps are parallel to each other and to the base. (WB21)
 - b. Wire is mounted against terminal base. (WB21)
 - c. On straight pins, the top wire on terminal is one diameter below the top of the terminal. (WB21)
 - d. Wraps are a minimum of 180 degrees and a maximum of 270 degrees. (WB21)
- 14.4.7 **Connection Reqts – Bifurcated Terminals – Side Route Attachments**
 - a. The wire or lead contacts two parallel faces (180 degree bend) of the terminal post. (WB21)
 - b. The cut end of the wire contacts the terminal. (WB21)
 - c. No overlapping of wraps. (WB21)
 - d. Wires placed in ascending order with largest on the bottom. (WB21)
 - e. Multiple wire attachments alternate terminal posts. (WB21)
- 14.4.8 **Connection Reqts – Bifurcated Terminals – Bottom & Top Route Attachments**
 - a. Wire insulation does not enter base or posts of terminals. (WB21)
 - b. Bottom wrap wire route contacts two parallel sides of post (180 degrees). (WB21)
 - c. Wire is against base of terminal. (WB21)
 - d. Top route wire has space between posts filled by using separate filler or bending the wire double. (WB21)
- 14.4.9 **Connection Reqts – Bifurcated Terminals – Staked Wires**
 - a. Wire terminated with a 90 degree bend or inserted straight through bifurcated posts or opening in pierced/perforated terminal with mechanical support. (WB21)
 - b. Wire is permanently staked or component body bonded to the board or adjacent surface constrained by a permanent mounting device. (WB21)
 - c. Wire contacts base of terminal or the previous wire. (WB21)
 - d. Wire extends through posts of bifurcated terminal. (WB21)
 - e. Wire extends beyond the eye of pierced/perforated terminals. (WB21)
 - f. Wire contacts two sides of pierced/perforated terminals. (WB21)
- 14.4.10 **Connection Reqts – Slotted Terminals**
 - a. Lead or wire extends completely through slot and is visible on the exit side. (WB21)
 - b. Wire is in contact with base of terminal area or previously installed wire. (WB21)
- 14.4.11 **Connection Reqts – Pierced/Perforated/Punched Terminals**
 - a. Wire passes through the eye of the terminal. (WB21)
 - b. Wire wrapped to contact opposite sides of the terminal. (WB21)
 - c. Insulation clearance one wire diameter. (WB21)
- 14.4.12 **Connection Reqts – Hook Terminals**
 - a. Wire wrap contacts terminal for a minimum of 180 degrees. (WB21)
 - b. Minimum of one wire diameter space from end of hook to the closest wire. (WB21)
 - c. Wires attached within the 180 degree arc of the hook. (WB21)

- d. Wires do not overlap. (WB21)
- e. Insulation clearance one wire diameter. (WB21)
- 14.4.13 **Connection Reqts – Cup Terminals**
 - a. Solder cups having the wire(s) inserted straight in and contact the back wall of other inserted wires for the full depth of the cup. (WB21)
- 14.4.14 **Connection Reqts – Series Connected Terminals**
 - a. Stress relief radii between each terminal. (WB21)
 - b. Turrets – Wire contacts base of terminal or a previously installed wire, and wraps around or interweaves each terminal. (WB21)
 - c. Hooks – Wire wrap 360 degrees around each terminal. (WB21)
 - d. Bifurcated – Wire passes between posts and contacts base of terminal or previously installed wire. (WB21)
 - e. Pierced/Perforated – Wire contacts two nonadjacent sides of each terminal. (WB21)
- 14.4.15 **Solder Reqts -General**
 - a. Solder fillet appears generally smooth and exhibits good wetting of the solder to the parts/wires being joined. (SD03)
 - b. Outline of the part/wire is easily determined. (SD12)
 - c. Solder at the part/wire being joined has a feathered edge. (SD02)
 - d. Fillet is concave in shape. (SD02)
- 14.4.16 **Solder Reqts –Fillet**
 - a. Solder fillet 100% of the circumference of the wire/lead and terminal interface (full extent of wrap). (SD12)
 - b. Height (climb on wire) of solder is greater than 75% of wire diameter. (SD02)
 - c. Solder wets the wire/lead and terminal and forms a discernible fillet feathering out to a smooth edge. (SD03)
 - d. Wire/lead is clearly discernible in the solder connection. (SD12)
 - e. No blowholes, pinholes, or voids. (SD11)
- 14.4.17 **Solder Reqts –Turret Terminals**
 - a. Lead outline is discernible, smooth flow of solder on wire and terminal. . (SD12)
 - b. Solder fillet at all point of wire/lead and terminal interface. (SD02)
- 14.4.18 **Solder Reqts –Bifurcated Terminals**
 - a. Lead outline is discernible, smooth flow of solder on wire and terminal. . (SD12)
 - b. Solder fillet at all point of wire/lead and terminal interface. . (SD02)
- 14.4.19 **Solder Reqts – Slotted Terminals**
 - a. Solder forms a fillet with that portion of the lead or wire that is in contact with the terminal. (SD02)
 - b. There is visible insulation clearance. (WB21)
- 14.4.20 **Solder Reqts – Pierce/Perforated Terminals**
 - a. Lead outline is discernible, smooth flow of solder on wire and terminal. . (SD12)
 - b. Solder fillet at all point of wire/lead and terminal interface. . (SD02)
- 14.4.21 **Solder Reqts – Hook Terminals**
 - a. Lead outline is discernible, smooth flow of solder on wire and terminal. . (SD12)
 - b. Solder fillet at all point of wire/lead and terminal interface. (SD02)
- 14.4.22 **Solder Reqts – Cup Terminals**
 - a. Solder wets the entire inside of the cup. (SD03)
 - b. Solder fill is 100%.. (SD02)
 - c. Outside of cup free of solder. (SD09)

14.5 **Crimp Terminations (Ref. Section 5 of IPC/WHMA-A-620)**

14.5.1 **Stamped & Formed Contacts**

a. **Insulation Support Crimp**

- (1) Insulation fully enters and extends past the insulation crimp tabs. . (WB18)
- (2) If multiple wires are used insulation from all wires extend past the insulation crimp tabs. (WB18)
- (3) Insulation crimp does not cut or break insulation. (WB18)
- (4) Insulation crimp tabs fully wrap and support insulation. (WB18)
- (5) For insulated lugs, the insulation crimp is evenly formed and contacts the wire insulation providing support without damaging the insulation. (WB18)

b. **Insulation Inspection Window**

- (1) Insulation and conductor transition line centered within the inspection window. (WB18)

c. **Conductor Crimp**

- (1) No insulation in the conductor crimp area. (WB18)
- (2) Conductor extends to the middle of the brush area. (WB18)
- (3) No conductor strands broken, folded back into crimp area or not captured by the conductor crimp tabs. (WB18)
- (4) Crimp centered on the conductor crimp area with correct bellmouth. (WB18)
- (5) Crimp indentations uniform and meet contact/tooling manufacturer's requirements. (WB18)
- (6) No deformation of contact such as a banana shape after crimping. (WB18)
- (7) Locking tabs in place with no signs of deformation or damage. (WB18)
- (8) Conductor strands not twisted, cut or modified to fit into the terminal. (WB18)

d. **Crimp Bellmouth**

- (1) Bellmouth at each end of the conductor crimp area. (WB18)
- (2) Bellmouth height at the conductor entry end is 2X the thickness of the contact/terminal base metal. (WB18)

e. **Conductor Brush**

- (1) The conductor strands protrude slightly past the end of the conductor crimp forming a "conductor brush." (WB18)
- (2) The conductor strands forming the brush are kept together as a group and not flared out. (WB18)

f. **Carrier Cutoff Tab**

- (1) Correct dimensions and no damage to contact or terminal. (WB18)

14.5.2 **Machined Crimp Contacts**

a. **Insulation Clearance**

- (1) 50% overall wire diameter clearance between the insulation and contact barrel. (WB18)

b. **Insulation Support**

- (1) Wire insulation seated in the insulation support entry funnel. (WB18)

c. **Conductor Location**

- (1) Conductor bottomed in the contact. (WB18)
- (2) Conductor strands fill the inspection window. (WB18)

- (3) No conductor strands outside of the contact. (WB18)
- d. **Crimping**
 - (1) Crimp indent is centered between the inspection window and the wire entry of the barrel. (WB18)
 - (2) Crimp indents around the contact barrel are evenly spaced and of equal depth. (WB18)
 - (3) No loose wire strands. (WB18)
 - (4) Contact has no visible fractures, cracks or exposed base metal. (WB18)

e. **Under Size Conductor – CMA Buildup Crimps**

- (1) The circular mil area of the conductor is built up so that it falls within the minimum and maximum CMA range of the contact. (WB18)
- (2) The CMA range is built up using one of the methods listed below:
 - (a) The conductor is folded or bent back to achieve the correct CMA buildup. (WB18)
 - (b) The conductor area is increased by the use of bare (non-insulated) filler conductors as needed to achieve the correct CMA buildup. (WB18)
 - (c) A combination of both the foldback and the filler method are used to achieve the correct CMA buildup. (WB18)
 - (d) Special “CMA Adaptor Bushings” are used when called out on the assembly documentation. (WB18)
- (3) The filler is visible at the wire entry end of the barrel. (WB18)

14.6 Insulation Displacement Connection (Ref. Section 6 of IPC/WHMA-A-620)

14.6.1 **Mass Termination, Flat Cable**

a. **End Cutting**

- (1) The cable is cut perpendicular to the cable edge. (WB21)
- (2) Cable is cut straight with no visible variation (wave or unevenness). (WB21)
- (3) No conductor strands protrude beyond the insulation of the cable. (WB17)

b. **Notching**

- (1) The connector mounting notches are cut parallel to the conductors and does not reduce the wire insulation. (WB21)
- (2) The notch length and width allows correct connector mounting including strain relief clips or covers if used. (WB21)

c. **Planar Ground Plane Removal**

- (1) Planar ground screen removed prior to installing and crimping an IDC connector to the cable. (WB22)
- (2) No insulation damage such as cuts or nicks. (WB04)

d. **Connector Position**

- (1) Cut end of the cable is flush with the outside of the connector body. (WB21)
- (2) The connector cover is fully compressed to the connector body along its entire length. (HA04)
- (3) Cover hold down latches are fully engaged and latched. (HA04)
- (4) Cable foldback inside radius, if applicable, is two cable thicknesses. (WB21)

e. **Connector Skew and Lateral Position**

- (1) Connector is aligned perpendicular to the edge of the flat cable. (WB21)

- (2) Cable end is flush along the entire length of the outside edge of the connector. (WB21)
- (3) All conductors are centered within the v-notch of the connector contacts. (WB21)

f.. **Retention**

- (1) Wires are retained in the connector. (WB21)
- (2) Strain relief features of the connector, if applicable, are utilized. (WB21)
- (3) Where present, connector-locking tabs are properly engaged (WB21).

14.6.2

Discrete Wire Termination

a. General

- IDCs shall not be mechanically stressed after making the connection, e.g. the connection must not be “repaired” afterwards by moving the wire or the mechanics of the slot. (WB21)

b. Position of Wire

- Connection area of the wire is in the center in the connection area of the slot. (WB21)

c. Overhang (Extension)

- Overhang of the wire extends to the far edge of the IDC connectors (WB21).

d. Wire Holder

- Both holders bent snug to insulation. (HA08)
- Maximum height of the holders is below the top of the housing. (DM01)

e. Damage in Connection Area

- There is no damage in the construction of the slot(s) on the circled area shown in the IPC standard, paragraph 6.2.5. (WB04)

f. End Connectors

- Wire fully seated into the contact. (WB21)
- Wire extends at least 50% of the distance between the contact edge and the back wall of the connector (WB21).

g. Wiremount Connectors

- Connector perpendicular in relation to the cable/wire centerline (WB21).

h. Subminiature D-Connector (Series Bus Connector)

- Wire ends flush with termination cover plates or extend less than 0.5 mm (WB21).

i. Subminiature D-Connector (RJ Type)

- All wires are bottomed in connector and visible through the front of the connector. (WB21)
- The primary strain relief is crimped tightly against the cable jacket (WB21).
- The cable jacket extends past the point of the strain relief. (WB21)
- For connector without a loading bar, the secondary strain relief is crimped so that it is in contact with the insulation (WB21).
- The contacts are crimped so that no part of the contacts are above the plane created by the top of the plastic dividers between the contacts. (WB21)

14.7 Ultrasonic Welding (Ref. Section 7 of IPC/WHMA-A-620)**14.7.1 Insulation Clearance**

- a. End of insulation is between one and two wire diameters from weld nugget (WB22).

14.7.2 Geometry

- a. Nugget width to height ration is 1.5 to 1. (WB21)
- b. Individual wire strands are not distinguishable on compression surfaces (top and bottom) of nugget. (WB21)

14.8 Splices (Ref. Section 8 of IPC/WHMA-A-620)**14.8.1 Soldered Splices**

- a. Using splices to repair broken or damaged conductors is not permitted without MRB approval. When allowed, see acceptance criteria below for the type of repair performed.

(1) Mesh

- (a) Interlocking of conductor strands into a smooth joined section for a minimum of three but not more than five wire diameters. (WB18)
- (b) Insulation covers splice and overlaps wire insulation a minimum of one wire diameter. (WB18)
- (c) No conductive strands piercing the insulation. (WB18)

(2) Wrap

- (a) Interlocking of two wire strands into a smooth joined section for a minimum of three wraps of each conductor. (WB18)
- (b) No conductive strands piercing the insulation. (WB18)
- (c) Insulation covers splice and overlaps wire insulation a minimum of one wire diameter. (WB18)

(3) Hook

- (a) Interlocking of two wire strands into a smooth joined section for a minimum of three wraps. (WB18)
- (b) No conductive strands piercing the insulation. (WB18)
- (c) Insulation covers splice and overlaps wire insulation a minimum of one wire diameter. (WB18)
- (d) Conductive strands form a smooth joined section. (WB18)
- (e) Conductive strands are covered with insulation. (WB18)

(4) Lap

- (a) Wires are parallel for at least three but not more than five wire diameters. (WB18)
- (b) Conductive strands form a smooth joined section. (WB18)
- (c) Insulation covers splice and overlaps wire insulation a minimum of one wire diameter. (WB18)
- (d) No conductive strands piercing the insulation. (WB18)

14.8.2 Splices - Crimped**a. Splices – Crimped – Barrel**

- Wire insulation is flush against end of barrel splice. (WB18)
- Bare wire ends are flush with barrel splice, bellmouth evident. (WB18)
- Crimp is centered and properly formed to retain wires. (WB18)

- Barrel splice is not cracked. (WB18)
- Sleeving extends past the bare wire conductors 6 mm minimum on both sides of the barrel splice. (WB18)
- b. Splices – Crimped – Double Sided**
 - Ends of wire are visible through the inspection window and are flush to the wire stop. (WB18)
 - Bellmouth is evident. (WB18)
 - Wire insulation is flush with ends of splice. (WB18)
 - Crimp is centered and properly formed to retain wires. (WB18)
 - Heat shrinkable sleeve is centered and overlaps both insulation gaps. (WB18)
 - Correct color-coded heat shrinkable sleeve used. (WB18)
 - Heat shrinkable sleeve is centered on the ferrule. (WB18)
 - Meltable sleeving rings have flowed. (WB18)
- c. Slices – Ultrasonic Welded**
 - Refer to Ultrasonic splice requirements.

14.9 **Connectorization (Ref. Section 9 of IPC/WHMA-A-620)**

14.9.1 **Hardware Mounting - Jackscrews**

- Jackscrew face is flush to 0.75 mm (0.030”) below the face of the connector. (HA08)
- Height is obtained by adding or removing washers (supplied with jackscrews). (HA08)

14.9.2 **Strain Relief - Sleeving**

- Sleeving is visible between the clamp and the connector. (WB07)
- The split-lock washers are collapsed. (WB07)

Note: Clamps must be tightened to secure the bundle, but need not be fully closed (touching).

14.9.3 **Sleeving and Boots**

14.9.3.1 **Sleeving and Boots – Position**

- Boot is securely shrunk on the rear of the connector adapter (crimp ring area). (HA09)
- Boot does not cover threaded adapter ring. (HA09)
- Boot overlap of cable sleeving or jacket is at least three cable diameters in length to prevent exposed wires or braid when fixed. (HA09)
- Boot overlap does not interfere with operation of locking ring. (HA09)

14.9.3.2 **Sleeving and Boots – Bonding –Conductive Adhesive**

- The boot is bonded to the connector on all sides with minimal adhesive buildup. The structural adhesive (typically black) fillet is visible. (BC01)
- The boot is parallel with the face of the connector in both axis. (DM19)
- There is no conductive adhesive (typically silver) outside the boot. (BC04)

14.9.4 **Connector Damage**

14.9.4.1 **Criteria**

- Shell surface is clean, unmarked, and undamaged. (HA07)
- Key or keyways are not distorted or damaged or mispositioned. (HA07)

14.9.4.2 Limits – Hard Face – Mating Surface

- Connector face is intact with no evidence of chipping, cracks, or other damage. (HA07)

14.9.4.3 Limits – Soft Face – Mating Surface or Rear Seal Area

- Connector face is intact, with no evidence of cracks, chips or damage. (HA07)

14.9.4.5 Contacts

- All connector contacts are to be installed in the connector to ensure they are fully seated and locked into position. (HA08)
- All locations in connector have been filled. (HA07)

Note: See comments in IPC/WHMA-A-620, section 9.4.4.

14.10 Molding/Potting (Ref. Section 10 of IPC/WHMA-A-620)**14.10.1 Molding****14.10.1.1 Molding – Insulation Damage**

- No insulation damage. (WB04)

14.10.1.2 Molding – Filling

- Mold filled completely with no recessions, bubbles, blowthroughs or other cosmetic or functional abnormalities. (CM13)

14.10.1.3 Molding – Terminal Positioning

- Terminals fully inserted and aligned as required by drawing or specification. (WB08)

14.10.1.4 Molding – Fit to Wire or Cable

- Molded material provides intimate contact with the wire or cable jacket for entire circumference of the wire or cable. (CM14)

14.10.1.5 Molding – Flashing

- No flashing. (DM22)

14.10.1.6 Molding – Chill Marks (Knit Lines), Stress Lines or Cracks

- No chill marks or stress lines. (FF10)

14.10.1.7 Molding – Compound Color

- Color is uniform and in accordance with drawing or specification. (FF02)

14.10.2 Potting**14.10.2.1 Potting – Filling**

- Potting material extends over insulation of all wires. (CM13)
- No potting material on the mating surfaces of the connector. (CM13)
- No bubbles or entrapped air. (CM13)
- No spillage. (CM13)

14.10.2.2 Potting – Fit to Wire or Cable

- Potting material provides intimate contact with the wire(s) or cable jacket for entire circumference of the wire(s) or cable. (CM13)

14.10.2.3 Potting – Curing

- Potting material is within manufacturer's specified hardness range and tack free to the touch after following the manufacturer's recommended cure schedule. (CM14)

14.11 Cable Assemblies and Wires (Ref. Section 11 of IPC/WHMA-A-620)**14.11.1 Cable Assemblies**

14.11.1.1 **Length Measurement**

- Cable length meets specified nominal drawing length. The length of the cable is measured from one end of the cable assembly to the other end. If reference surfaces and/or tolerances are not specified on documentation, see IPC/WHMA-A-620, section 11. (DM01)

14.11.2 **Wires (As an assembly)**14.11.2.1 **Length Measurement**

- The wire lengths from one wire end reference location or reference surface to the other are equal to the “nominal” wire length (nom). If reference locations are not specified on the documentation, see IPC/WHMA-A-620, section 11. (DM01)

14.12

Marking/Labeling (Ref. Section 12 of IPC/WHMA-A-620)14.12.1 **Content**

- Markings include the content specified by the controlling document. (MA02)

14.12.2 **Legibility**

- Markings are legible when viewed without magnification. Markings are distinct, of uniform height, and of a color that contrasts with the background. (MA01)
- Machine-readable markings (bar codes) must be of the proper specified industry standard format. (MA04)
- Bar codes can be read successfully with one attempt using a wand or laser type scanner. (MA04)

14.12.3 **Permanency**

- Markings shall remain legible after exposure to handling, assembly and required environmental testing. (MA01)

14.12.4 **Location**

- Marking present in location(s) designated by controlling document. (MA03)

14.12.5 **Functionality**

- The marking does not impair the function of the product in its intended design. (MA03)
- The marking process has not damaged the product. (MA03)

14.12.6 **Marker Sleeve**14.12.6.1 **Marker Sleeve - Wraparound**

- The marker sleeve wraps around the cable 1.5 times and is secure. (MA05)
- The overlap of the marker sleeve is aligned at the edges. (MA05)
- The marker sleeve is smooth. (MA05)

14.12.6.2 **Marker Sleeve - Tubular**

- The identification marking reads toward the connector. (MA05)
- The marker sleeve is completely shrunk and secure. (MA05)
- The marker sleeve is positioned next to the boot (or connector when no boot exists). (MA05)

14.13

Coaxial and Twinaxial Cable Assemblies (Ref. Section 13 of IPC/WHMA-A-620)14.13.1 **Stripping**

- Smooth, clean cut; no jagged edges. (WB04)
- No burn marks or damage on insulation or dielectric. (WB04)
- Braid/shield cut even; no long strands. (WB04)
- Braid lies smooth and flat after cut with no damage or loose pieces. (WB04)

14.13.2 **Center Conductor Termination**

- 14.13.2.1 **Center Conductor Termination - Crimp**
 - Crimp is centered on crimp area of terminal. (WB21)
 - No damage to terminal or dielectric. (WB04)
- 14.13.2.2 **Center Conductor Termination - Solder**
 - During assembly, center conductor visible across full diameter of inspection window. (WB21)
 - The inspection window is filled with solder. (SD02)
 - No solder on outside of terminal. (SD09)
 - Solder in inspection window does not protrude beyond terminal barrel. (WB21)
 - Solder is wetted to both the terminal and the conductor. (SD03, SD04)
 - No melt/damage to dielectric or terminal. (WB04)
 - No residue when connection is required to be clean. (SD17)
 - Terminal is flush against dielectric. (WB21)
- 14.13.3 **Solder Ferrule Pins**
 - 14.13.3.1 **Solder Ferrule Pins - General**
 - Solder fillet is evident in inspection holes. (SD02)
 - Shield weave pattern is intact. (WB04)
 - 14.13.3.2 **Solder Ferrule Pins - Insulation**
 - Pin tip insulation shows no evidence of melting. (WB04)
 - Insulation in inspection hole is flush with outside pin surface. (WB21)
- 14.13.4 **Coaxial Connector – Printed Wire Board Mount**
 - Wire is positioned and centered between the four connector leads. (WB21)
 - Shield weave pattern is intact. (WB04)
 - Solder fillet is evident between shield and connector. (SD02)
 - Sleeve completely covers shield. (WB21)
- 14.13.5 **Coaxial Connector – Center Conductor Length – Right Angle Connector**
 - Center conductor is flush with edge of the slotted terminal. (WB11)
 - End of dielectric is flush with inside of connector cavity. (WB11)
- 14.13.6 **Terminal Cover - Soldering**
 - Continuous solder fillet between connector body and cover. (SD02)
- 14.13.7 **Shield Termination**
 - 14.13.7.1 **Shield Termination – Clamped Ground Rings**
 - Braid/shield evenly distributed around the ground ring. (WB18)
 - Shield wires are close to, but not in contact with, the outer shoulder flange of the shield ground ring. (WB18)
 - Shield ground wires hold the shield ground ring in tight contact with the cable outer jacket. (WB18)
 - 14.13.7.2 **Shield Termination – Crimped Ferrule**
 - Crimp on ferrule located tight against connector body (WB18).
 - Ferrule butted up tight to connector body. (WB18)
 - Connector and/or ferrule do not turn or move on cable after crimping. (WB18)
- 14.13.8 **Center Pin Position**
 - Center pin fully seated into housing of connector. (DM01)
 - Pin height is correct. (DM01)
- 14.13.9 **Semirigid Coax**
 - 14.13.9.1 **Semirigid Coax – Bending and Deformation**
 - Bend is uniform and has an inside radius greater than 3.5 times the cable diameter. (CM21)

- Diameter of cable is constant and does not deform in the bend area. (CM21)
- No evidence of wrinkles. (CM21)
- 14.13.9.2 **Semirigid Coax – Surface Condition**
 - Outside surface of the cable is smooth. (DM16)
 - No tool marks, scratches or abrasions. (DM16)
- 14.13.9.3 **Semirigid Coax – Dielectric Cutoff**
 - Dielectric is flush with connector face. (DM01)
 - No air gaps between dielectric and cable shield. (DM01)
 - Center conductor is perpendicular to dielectric/connector face. (DM01)
 - Shield roll is minimal. (DM01)
- 14.13.9.4 **Semirigid Coax – Dielectric Cleanliness**
 - Dielectric material has no foreign particles (metallic or nonmetallic) embedded in or on its surface. (GN10)
- 14.13.9.5 **Semirigid Coax - Solder**
 - Solder fillet 100% around the connector body and cable. (SD02)
 - No solder outside joint region. (SD09)
 - No residue when connection is required to be clean. (SD17)
 - No voids or separation between connector body and cable. (SD11)
 - No solder on connector body. (SD09)
 - Shield inserted in connector body. (WB21)
- 14.13.10 **Swage-Type Connector**
 - Swage ferrule is compressed into the connector body. (HA08)
 - Gap between ferrule shoulder and nut face does not exceed 0.5 mm (0.02"). (DM01)
- 14.13.11 **Soldering and Stripping of Biaxial or Twinaxial Wire – Low Temperature Insulation**
 - 14.13.11.1 **Low Temperature Insulation - Jacket and Tip Installation**
 - Cone is under shield and jacket. Shield is flush with edge of cone. (WB21)
 - Tip conductor insulation is extended more than 50% of window length in (notched insert), and there is no exposed wire showing. (WB21)
 - Solder on the solder section of tip is flush to slightly concave. (WB21)
 - 14.13.11.2 **Low Temperature Insulation – Ring Installation**
 - Wire, insulation, or solder does not extend above ring profile (WB21).
- 14.14 **Wire Bundle Securing (Ref. Section 14 of IPC/WHMA-A-620)**
 - 14.14.1 **Tie Wrap/Lacing Application**
 - 14.14.1.1 **Tie Wrap/Lacing Application - General**
 - The first and last stitch of continuous lacing is tied with a clove hitch and secured with a square knot, surgeons knot, or other approved knot. (WB07)
 - Continuous lacing is done with lock stitches. (WB07)
 - Continuous lacing utilizes a double lock stitch before and after each breakout of four or more wires. (WB07)
 - Continuous branch lacing is started on the trunk. (WB07)
 - Lacing is trimmed 10 mm (0.40") after the knot. (WB07)

- Restraining devices are locking. (They should remain secure for the expected service life of the product.) (WB07)
 - Cut end of the wrap is square and flush to the face of the tie wrap. (WB07)
- 14.14.1.2 **Tie Wrap/Lacing Application - Tightness**
- Restraining devices do not move. (WB07)
 - Restraining devices do not cause noticeable indentation or distortion of the wires of the assembly. (WB07)
- 14.14.1.3 **Tie Wrap/Lacing Application - Damage**
- Restraining devices are not worn, frayed, nicked, or broken in any location. (WB04)
 - Restraining devices do not have sharp edges that may be a hazard to personnel or equipment. (WB04)
- 14.14.1.4 **Tie Wrap/Lacing Application - Spacing**
- Spacing of restraining devices from the rearmost connector assessor or between each other is three diameters of the wire bundle or 10 cm (4 inches) whichever is less. (WB01)
 - Spacing of restraining devices is uniform. (WB01)
- 14.14.2 **Breakouts**
- 14.14.2.1 **Breakouts – Individual Wires**
- A restraining device is used prior to each breakout. (WB07)
 - If continuous lacing is used, the first wire breakout in a series is double lock stitched. (WB07)
 - A double lock stitch is used before and after any breakout of four or more wires. (WB07)
- 14.14.2.2 **Breakouts – Individual Wires**
- Restraining device is used immediately before and after each branch. (WB07)
 - The closest restraint on any branch of a breakout is two diameters of that bundle or 1.25 cm (0.5 inch) whichever is greater. (WB07)
- 14.14.3 **Wire Bundles**
- 14.14.3.1 **Wire Bundles – Wire Crossover**
- Wire lay is essentially parallel to the axis of the bundle with no crossover. (WB07)
 - Spot ties or tie straps around the bundle are tight but not to the point of cutting or permanently damaging the wire insulation. (WB07)
 - Spot ties or tie straps are spaced evenly and at an increment that will maintain the bundles rigidity and desired form. (WB07)
- 14.14.3.2 **Wire Bundles – Coaxial Cable Routing**
- Inside bend radii for coaxial cable is equal to or greater than five times the coax cable diameter (including insulation). (WB07)
- 14.14.3.3 **Wire Bundles – Unused Wire Termination**
- Ends of unused wires are covered with shrink sleeving. (WB21)
 - Wire is folded back inside the sleeving (WB21).
 - Sleeving covers end of wire (WB21).
 - Unused wire is tied into the wire bundle (WB21).
- 14.14.3.4 **Wire Bundles – Ties Over Splices and Ferrules**

- Spot ties or straps are placed over or near splices contained in the wire bundle. (WB07)
- No stress on wires exiting splices. (WB07)

14.15 **Shielding (Ref. Section 15 of IPC/WHMA-A-620)**

14.15.1 **Braided**

14.15.1.1

Braided – Direct Applied

- Braid coverage meets drawing requirements (WB23).
- Braiding is not so tight as to cause indentation or distortion to the wires of the assembly (WB23)..
- Braid is free of loops (WB23)..
- All loose strands are trimmed flush and terminated with solder or tape (WB23)..
- No fraying or unraveling of braid ends (WB23)..
- No visible wire or shield braid through the fabric braid (WB23)..
- Braid strands smooth and evenly placed (WB23)..
- 38 mm (1.5 inches) overlap of material at branches and breakouts (WB23)..
- Back braid lock stitch is a minimum of 13 mm (0.5 inch). (WB23).

14.15.1.2

Braided – Pre-Woven

- Braid is smooth with firm contact against the wires (WB23)..
- Free of ballooning or bunching (WB23)..
- Ends secured with no fraying or unraveling. (WB23).

14.15.2 **Shield Termination**

14.15.2.1

Shield Termination – Pick Off

- The solder preform (ring) is melted and a fillet is visible between shield and pick off. Shield and pick off lead contour is tinned and discernible. (SD02)
- Shield and pick off strip length are the same length and are lined up. (DM01)
- Melttable sealing rings have flowed. (SD02)
- Sleeve and wire insulation shows no discoloration due to excessive heat. (WB04)
- Shield weave pattern is intact. (WB04)
- Solder ferrules used in a daisy chain application are staggered within the specified limits from the end of the wire to minimize buildup. (WB21).

Note:

Ferrules/splices may be located under clamps as long as protection is provided under the clamp, i.e. tape/sleeving or grommet.

- Shield used as a pick off, shield weave pattern is intact. (WB04).

14.15.2.2

Shield Termination – No Pick Off

- Exposed shield is less than 3 mm (0.12”) in length. . (DM01)
- Sleeving overlaps 6 mm (0.25”) beyond the exposed shield in each direction. . (DM01)
- Loose strands are not evident under the sleeving. . (WB04)
 - No discoloration on sleeving or wire insulation. (WB04)
 - Shield terminations are staggered within the specified limits from end of wire. (CM04)

14.15.2.3 **Shield Termination – Low Temperature Insulated Wire – With Pick Off**

- Smooth, concave solder fillet between shield and pick off. Shield and pick off lead is tinned and is discernible. (SD02)
- Flux residue from cleanable flux has been removed prior to shrinking of the sleeving. (SD17)
- Sleeve and wire insulation shows no discoloration or melting. (WB04)
- Shield weave pattern is intact. (WB04)

14.15.3 **Shield Termination – Shrink and Crimp**

- Shrinkable ring is shrunk. No movement of the ring or shield is evident. (Ring has lost its original color.) . (WB18)
- Shield is visible between shrinkable ring and the backshell. . (WB18)
- Shield is approximately 3 mm (0.12 in) from backshell. . (WB18)
- Shield weave pattern is intact. . (WB18)
- Band is wrapped around the shield twice and clinched. No movement of the ring or shield is evident. . (WB18).
- Sharp edges of the band cut off area have been removed or covered with epoxy. (WB18)
- Shield is visible between the band and the backshell. . . (WB18)

14.15.4 **Shield Termination - Splicing**

- Tack solder is attaching all breakouts. . (SD01)
- The spliced area is flexible. . (WB07)
- Shield overlap is two times the diameter of the large (combined) wire bundle. . (HA08)
- Shield weave pattern is undisturbed. . (CM08)

14.15.5 **Tapes – Barrier and Conductive, Adhesive or Non-Adhesive**

- 50% overlap of tape. (HA08)
- Conforms to bundle. (HA08)
- Tape ends secured. (HA08)

14.15.6 **Conduit (Shielding)**

- Conduit is free of dents, kinks or cracks. . (CM11)
- No sharp edges or burrs at conduit ends. . (CM11)
- If conduit is plated, no base metal exposed. . (CM11)

14.15.7 **Conductive Coating**

- Conductive coating shows no loss of adhesion from the base material. . (CM14)
- Coating is free of voids, bubbles, blisters, peeling or flaking. . (CM13)
- Coating does not contain foreign material. . (FD01)

14.15.8 **Shrink Tubing – Conductive Lined**

- Tubing is tight on cable and connector/cable accessories. . (HA04)
- No cracks or tears. . (CM11)
- No overlapping of tubing. . (HA08)
- Multiple pieces electrically connected. . (HA08)

14.16 **Cable/Wire Harness Protective Coverings (Ref. Section 16 of IPC/WHMA-A-620)**

14.16.1 **Braid – Direct Applied**

- Braiding is not so tight as to cause indentation or distortion to the wires of the assembly. (WB21).
- No fraying or unraveling of braid ends. (WB21).
- Braid strands smooth and evenly placed. (WB21).

- 1 ½ inch overlap of material at branches and breakouts. (WB21).
 - Back braid lock stitch is a minimum of 13 mm (0.5 in) (WB21).
- 14.16.2 **Taping**
- Tape is installed with a 50% overlap. (HA08)
 - Tape does not bunch or add excessive bulk to bundle. . (HA08)
 - Ends are secured. . (HA08)
- 14.16.3 **Sleeving – Shrink Tubing**
- Tubing is tight on cable and connector/cable accessories. . (HA04)
 - No cracks or tears. . (CM11)
 - Multiple pieces overlapped by at least 13 mm (0.5 in). . (HA08)
- 14.16.4 **Spiral Plastic Wrap (Spiral Wrap Sleeving)**
- Spiral sleeving makes firm contact with the bundle. (HA08).
 - Ends trimmed to eliminate sharp edges or points. (HA08).
 - The sleeving is applied butt or open spiral, but does not overlap. (HA08).
 - The ends of the wrap are secured (HA08)..

14.17 **Installation of Cables and Wire Harness Assemblies (Ref. Section 17 of IPC/WHMA-A-620)**

- 14.17.1 **General**
- Wires and cables are positioned or protected to avoid contact with rough or irregular surfaces and sharp edges and to avoid damage to conductors or adjacent parts. . (WB07)
 - Minimum electrical clearance is maintained. (WB07)
 - Installation hardware is tight, including applicable torque if required. (WB07)
 - Wiring connections to ground are free of any protective finishes (e.g. paint, anodize coating, etc.) that can preclude an adequate ground connection. (WB07)
 - Wire routing meets requirements for drip loops, no mechanical interference, etc. (WB07)
 - Soldered connections meet the requirements of paragraph 14.4. (WB07)
 - Crimping meets the requirements of paragraph 14.5. (WB07)
 - Splice connections meet the requirements of paragraph 14.8. (WB07)
 - Wiring is terminated at the destination specified by the wire marker/documentation. (WB07)
 - Wire is not routed through “keep out” zones, e.g., hot surfaces or mechanical interference areas. (WB07)
 - Adhesives are applied at the required location and properly cured. (WB07)
 - Wire(s) not stressed. (WB07)
 - Design cable/wire/harness bend radius maintained. If not otherwise specified, the minimum bend radius is five to ten times the diameter of the wire or bundle, whichever is larger. (WB07)
 - Wire and cable are supported with mounting hardware to preclude stress. (WB07)
 - Cable ties, straps or clamps do not compress or damage wire insulation. (WB07)
 - If required, a service loop is provided to allow at least one field repair. (WB07)
- 14.17.2 **Hardware Installation**
- Proper hardware sequence is followed. . (HA08)
 - Slot and/or hole is covered with a flat washer. . (HA08)
 - Fasteners are tight and split-ring lock washers, when used, are fully compressed. . (HA04)
 - Proper torque applied when torque is a requirement. . (HA03)

- there is no evidence of burrs or frayed edges on the hardware. . (DM22)
- 14.17.3 **Hardware Installation - Wires**
- Strands of wire are tightly twisted together (stranded wire). . (HA08)
 - Wire wrapped a minimum of 270 degrees around the screw body. . (HA08)
 - Wire end secured under screw head. . (HA08)
 - Wire wrapped in the correct direction. . (HA08)
 - All strands are under screw head. . (HA08)
- 14.17.4 **Stress Relief/Wire Dress/Service Loops**
- The wire approaches the terminal with a loop or bend sufficient to relieve any tension on the connection during thermal/vibration stress. . (WB07)
 - The direction of the stress-relief bend places no strain on the mechanical wrap or the solder connection. . (WB07)
 - Sufficient service loop is provided to allow one field repair to be made. . (WB07)
- 14.18 **Solderless Wrap (Ref. Section 18 of IPC/WHMA-A-620)**
- 14.18.1 **Number of Turns**
- One-half (50%) more turn than the minimum shown in Table 18-1 of IPC/WHMA-A-620. (WB05)
- 14.18.2 **Turn Spacing**
- No space between any turns. . (WB01)
- 14.18.3 **End Tails, Insulation Wrap**
- No wire clippings present. . (WB09)
 - End tail does not extend beyond outer surface of wrap with insulation modified wrap. . (WB14)
- 14.18.4 **Raised Turns Overlap**
- No raised turns. (WB05)
- 14.18.5 **Connection Position**
- All turns of each connection on working length of terminal, visible separation between each connection. (WB01)
- 14.18.6 **Wire Dress**
- The dress of wire needs to be so oriented that force exerted axially on the wire will not tend to unwrap the connection, or to relieve the bite of wire on the corners of the terminal post. This requirement is satisfied when the wire is routed so as to cross the 45 degree line. (WB07)
- 14.18.7 **Wire Slack**
- Wiring needs to have sufficient slack so that it will not pull around corners of the other terminal posts or bridge and load other wires. (WB07)
- 14.18.8 **Plating**
- After wrapping, uninsulated wire has no exposed copper. (FF10)
- 14.18.9 **Damage**
- After initial contact with post: no insulation damage, splits or cuts and fraying on the wrap. . (WB04)
 - Wire finish is not burnished or polished, nicked, scraped, gouged or otherwise damaged. (WB04)
 - Wire wrap terminals shall not be burnished, scraped or otherwise damaged. (WB04)

15.0 INSPECTION OF ELECTRONIC ASSEMBLIES – VISUAL AND DIMENSIONAL INSPECTION REQUIREMENTS

15.1 General Requirements

All visual and dimensional inspections performed on material or product manufactured by or purchased for use in the Lansdale facility shall be in accordance with the requirements of this product acceptance procedure.

15.1.1 Magnification Requirements

- The inspection magnification of Table 1-2 of IPC-A-610 shall be used for all land widths or land diameters.
- The magnification aid applications of table 1-3 of IPC-A-610 for other criteria shall be used for cleanliness criteria, conformal coating criteria and other specified criteria such as component and wire damage.

15.2 Use of IPC-A-610

All inspections performed on cables and wire harness assemblies that are purchased or manufactured in the Lansdale facility shall be in accordance with the requirements of this product acceptance procedure and IPC-A-610. The User of this product acceptance procedure shall refer to the applicable section of the IPC standard whenever the quality of the product does not meet the requirements specified herein. The IPC standard provides additional guidance regarding the quality acceptance requirements depending upon the nature of the defect. When the additional guidance indicates that the condition is acceptable, the User shall accept the product. Any condition identified as a Process Indicator or a Defect condition shall be rejected.

Access to the latest revision of IPC-A-610 can be obtained as follows:

- (1) Access the SASL Sharepoint Site
- (2) Click on Applications on the left hand side of the screen.
- (3) Click on HIS – Specs and Standards
- (4) Click on the “IHS Standards Expert” link.
- (5) When the Security Alert box appears, click on the YES button.
- (6) Enter the document number in the Search block entitled Document Number or Organization and click on the “Search” button
- (7) Click on the “View” link to open the document that you are searching for.

15.2.1 Training/Certification

All personnel inspecting and accepting hardware to the inspection criteria of Section 15.0 of this standard and IPC-A-610 must be trained and certified by the Lansdale Mission Success and Product Assurance department.

15.3 Hardware

15.3.1 Hardware Installation (Ref. Section 4 of IPC-A-610)

15.3.1.1 Hardware Installation – Electrical Clearance

- Spacing between noncommon conductors does not violate specified minimum electrical clearance. (HA11)

15.3.1.2 Hardware Installation – Interference

- Mounting area clear of obstructions to assembly requirements. (HA11)

15.3.1.3 Hardware Installation – Threaded Fasteners

- A minimum of one and one half threads need to extend beyond the threaded hardware, (e.g., nut) unless otherwise specified by engineering drawing. Bolts or screws may be flush with the end of the threaded hardware only where threads could interfere with other components or wires and when locking mechanisms are used. (HA02)
- Thread extension should not be more than 3 mm [0.12 in] plus one and one-half threads for bolts or screws up to 25 mm [0.984 in] long or more than 6.3 mm [0.248 in] plus one and one-half threads for bolts or screws over 25 mm [0.984 in]. This is providing that the extension does not interfere with any adjacent part and that the designed electrical clearance requirements are met. (HA11)
- Proper hardware sequence. (HA08)
- Slots and holes are covered with flat washer. (HA08)

15.13.1.3.1 Hardware Installation – Threaded Fasteners – Torque

- Fastener torque value, if specified, is within limits. (HA03)
- Fasteners are tight and split-ring lock washers, when used, are fully compressed. (HA03)

15.3.1.4 Hardware Installation – Threaded Fasteners – Wire

- Original lay of the strands is not disturbed (stranded wire). (WB17)
- Wire wrapped a minimum of 270° around the screw body. (WB10)
- Wire end secured under screw head. (WB10)
- Wire wrapped in the correct direction. (WB10)
- All strands are under screw head. (WB10)

15.3.2 Connectors, Handles, Extractors, Latches

- No damage to part, printed board or securing hardware (rivets, screws, etc.). (CM11)

15.3.3 Connector Pins

15.3.3.1 Edge Pin Connectors

- Contact is not broken or twisted. Gap is within specified tolerance. (CM11)
- No land damage. (PC12)
- Contact is contained within the insulator. (CM21)

15.3.3.2 Press Fit Pins

- Pins are straight, not twisted and properly seated. (CM21)
- No discernible damage. (CM11)

15.3.3.3 Soldering

- A 360° solder fillet is evident on the secondary side of the assembly. (SD02)

Note: Solder fillet or fill on primary side is not required.

15.3.3.4 Backplanes

- Chip on nonmating surface of separable connector pin. (CM21)
- Burnish on mating surface of separable connector pin, providing that plating has not been removed. (CM21)
- Chip that encroaches the mating surface of separable connector pin which will not be in the mating connector contact wear path. (CM21)

15.3.4 Wire Bundle Securing

15.3.4.1 General

- Restraining devices are neat and tight, and spaced to keep the wires secured in a tight neat bundle. (WB10)

15.3.4.2 Lacing

- Lacing begins and ends with a locking knot. (WB10)

- Lacing is tight and wires are kept secure in a neat bundle. (WB10)

15.3.4.3 Damage

- Restraining devices are not worn, frayed, nicked, or broken in any location. (CM21)
- Restraining devices do not have sharp edges that may be a hazard to personnel or equipment. (CM21)

15.3.5 Routing

- These criteria are applicable to single wires or wire bundles.
- Wire bundles are positioned to minimize crossover and maintain a uniform appearance.

15.3.5.1 Wire Crossover

- Wire lay is essentially parallel to the axis of the bundle with no crossover. (WB10)
- Coaxial cable secured with tie wraps/straps. (WB10)

15.3.5.2 Bend Radius

- Minimum bend radius meets requirements of Table 4-1 of IPC-A-610. (WB10)

Note: Bend radius is measured along the inside curve of the wire or wire bundles.

15.3.5.3 Coaxial Cable

- Inside bend radii meets the criteria of Table 4-1 of IPC-A-610. (WB10)

15.3.5.4 Unused Wire Termination

- Sleeving extends three wire diameters past end of wire. (DM21)
- Unused wire is folded back and tied into the wire bundle. (DM21)

15.3.5.5 Ties over Splices and Ferrules

- Spot ties or tie wraps/straps are placed near splices or solder ferrules contained in the wire bundle. (WB10)
- No stress on wires exiting splices. (WB07)

15.4 Soldering (Ref. Section 5 of IPC-A-610)

15.4.1 Soldering Acceptability Requirements

- Solder fillet appears generally smooth and exhibits good wetting of the solder to the parts being joined. (SD05/SD06)
- Outline of the lead is easily determined. (SD12)
- Solder at the part being joined creates a feathered edge. (SD09)
- Fillet is concave in shape. (SD09)
- There are materials and processes, e.g., lead free alloys and slow cooling with large mass PCBs, that may produce dull matte, gray, or grainy appearing solders that are normal for the material or process involved. These solder connections are acceptable.
- The solder connection wetting angle (solder to component and solder to PCB termination) do not exceed 90°. (SD09)
- As an exception, the solder connection to a termination may exhibit a wetting angle exceeding 90° when it is created by the solder contour extending over the edge of the solderable termination area or solder resist.

15.4.2 Soldering Anomalies

15.4.2.1 Exposed Basis Metal

- Exposed basis metal on:
 - (a) Vertical conductor edges. (SD16)
 - (b) Cut ends of component leads or wires. (SD16)
 - (c) Organic Solderability Preservative (OSP) coated lands. (SD16)
- Exposed surface finishes that are not part of the required solder fillet area. (SD16)

15.4.2.2 Pin Holes/Blow Holes

- No pinholes, blowholes or voids. (SD11)

15.4.2.3 Reflow of Solder Paste

- Complete reflow of solder paste. (SD07)

15.4.2.4 Nonwetting

- Solder has wetted to the land or termination where solder is required. (SD03)
- Solder coverage meets requirements for the termination type. (SD03)

15.4.2.5 Dewetting

- No evidence of dewetting that causes the solder connection to not meet the SMT or through-hole solder fillet requirements. (SD04)

15.4.2.6 Excess Solder**15.4.2.6.1 Solder Balls/Solder Fines**

- No evidence of solder balls on the printed wiring assembly. (SD13)

15.4.2.6.2 Bridging

- No solder connection across conductors that should not be joined. (SD14)
- Solder has not bridged to adjacent noncommon conductor or component. (SD14)

15.4.2.6.3 Solder Webbing/Splashes

- No solder splashes/webbing. (SD14)

15.4.2.7 Disturbed Solder

- No disturbed solder joint that are characterized by stress lines from movement in the connection. (SD05)

15.4.2.8 Fractured Solder

- No fractured or cracked solder. (SD05)

15.4.2.9 Solder Projections

- Solder projection does not violate assembly maximum height requirements or lead protrusion requirements. (SD08)
- Projection does not violate minimum electrical clearance. (SD08)

15.4.2.10 Lead free – Fillet Lift

- Fillet lifting – no separation of the bottom of the solder and the top of the land on the primary side of plated-through hole connection. (SD05)

15.4.2.11 Hot Tear/Shrink Hole

- For connections made with lead free alloys:
 - (a) The bottom of the tear is visible. (SD11)
 - (b) The tear or shrink hole does not contact the lead, land or barrel wall. (SD05)

15.5 Terminal Connections (Ref. Section 6 of IPC-A-610)**15.5.1 Edge Clip**

- Clip is centered on land with no side overhang. (CM04)

15.5.2 Swaged Hardware

- This section contains criteria for the basic types of swaged hardware.

Terminals

Swaged hardware that overhangs the land is acceptable if it does not violate minimum electrical clearance. (HA11)

Solderability

Plating and solderability of swaged hardware should be consistent with appropriate plating and solderability specifications. (SD03)

15.5.1.1 Rolled Flange

- Rolled flange is uniformly swaged and concentric to the attachment hole. (CM21)

- Flange compression is sufficient to support the mechanical attachment of the terminal for the intended performance environment. (CM21)
- Terminal does not rotate or move once swaged. (CM21)
- No splits or cracks in the terminal swage. (CM21)
- Terminal post or attachment is perpendicular to the assembly surface. (CM21)
- The lip of the rolled flange is in full contact with the base laminate for the full circumference of the flange. (CM21)
- No laminate damage. (PC12)

15.5.1.2 Flared Flange

- Flared flange is uniformly swaged and concentric to the hole. (CM21)
- Strain or stress marks caused by flaring are kept to a minimum. (CM11)
- The flange is swaged sufficiently tight to prevent movement in the Z-axis. (CM21)

15.5.1.3 Controlled Split

- Flange is uniformly split and concentric to the hole. (CM21)
- Split segments do not extend to the outside diameter of the land. (CM11)
- Flange is swaged sufficiently tight to prevent movement in the Z-axis. (CM21)

15.5.1.4 Terminals

15.5.1.4.1 Turret

- Terminal intact and straight. (CM21)

15.5.1.4.2 Bifurcated

- Terminal intact and straight. (CM21)

15.5.1.5 Fused in Place

- Solder around periphery of flange. (SD02)
- Good filleting of solder around flange. (SD02)
- Good wetting of flange and terminal area. (SD03/SD04)
- The swaged flange needs to be as close to the land as possible to prevent movement in the Z axis. (CM21)
- Evidence of solder flow is discernible between swaged flange and land of the printed board or other substrate. (SD02)

15.5.2 Wire/Lead Preparation – Tinning

- Stranded wire is uniformly coated with a thin coat of solder with the individual strands of the wire easily visible. (SD09)
- Untinned length of strands from end of insulation is not greater than one wire diameter. (SD02)

15.5.3 Lead Forming – Stress Relief

- Component body centerline to terminal edge is at least one-half (50%) the component diameter or 1.3 mm [0.0511 in], whichever is greater. (CM21)
- Clip and adhesive mounted component leads have stress relief. (CM21)

15.5.4 Service Loops

- Sufficient service loop is provided to allow one field repair to be made. (WB07)

15.5.5 Terminals – Stress Relief Lead/Wire Bend

15.5.5.1 Bundle

- The wire approaches the terminal with a loop or bend sufficient to relieve any tension on the connection during thermal/vibration stress. (WB07)
- The direction of the stress-relief bend places no strain on the mechanical wrap or the solder connection. (WB07)
- Bend not touching terminal is in conformance with Table 7-1 of IPC-A-610. (WB07)

15.5.5.2 Single Wire

- The wire is formed around the terminal opposite to the feed-in direction. (WB10)
- The wire is straight between the connections with no loop or bend, but wire is not taut. (WB07)
- Bends are not kinked. See Table 7-1 of IPC-A-610. (WB04)

15.5.6 Lead/Wire Placement

- Wraps to a terminal are parallel with the terminal base and each other. (WB10)
- Wires are mounted as close to the terminal base as allowed by the insulation. (WB10)
- Wrapped conductors do not cross over or overlap each other on terminal. (WB10)
- Calibration parts may be mounted to the tops of hollow terminals. (WB10)

15.5.6.1 Turrets and Straight Pins

- Wraps parallel to each other and to the base. (WB10)
- Wire mounted against terminal base or previously installed wire. (WB10)
- On straight pins, the top wire on terminal is one wire diameter below the top of the terminal. (WB10)
- Wraps are a minimum of 180° and a maximum of 270°. (WB10)
- Wires and leads mechanically secure to terminals before soldering. (WB10)

15.5.6.2 Bifurcated**15.5.6.2.1 Side Route Attachments**

- The wire or lead contacts two parallel faces (180° bend) of the terminal post. (WB10)
- The cut end of the wire contacts the terminal. (WB10)
- No overlapping of wraps. (WB10)
- Wires placed in ascending order with largest on the bottom. (WB10)
- Multiple wire attachments alternate terminal posts. (WB10)

15.5.6.2.2 Bottom and Top Route Attachments

- Wire insulation does not enter base or posts of terminal. (WB10)
- Bottom route wire wrap contacts two parallel sides of post (180°). (WB10)
- Wire is against base of terminal. (WB10)
- Top route wire has space between posts filled by using separate filler or bending the wire double. (WB10)

15.5.6.3 Staked Wires

- Wire is permanently staked or constrained by a permanent mounting device. (WB10)
- Wire contacts base of terminal or the previous wire. (WB10)
- Wire extends through posts of bifurcated terminal. (WB10)
- Wire extends beyond the eye of pierced/perforated terminals. (WB10)
- Wire contacts two sides of pierced/perforated terminals. (WB10)

15.5.6.4 Slotted

- Lead or wire extends completely through slot and is discernible on the exit side. (WB10)

- Wire is in contact with base of terminal area or previously installed wire. (WB10)

15.5.6.5 Pierced/Perforated

- Wire passes through the eye of the terminal. (WB10)
- Wire wrapped to contact two nonadjacent sides of the terminal. (WB10)

15.5.6.6 Hook

- Wire wrap contacts terminal for a minimum of 180°. (WB10)
- Minimum of one wire diameter space from end of hook to the closest wire. (WB10)
- Wires attached within the 180° arc of the hook. (WB10)
- Wires do not overlap. (WB10)

15.5.6.7 Solder Cups

- Solder cups have the wire(s) inserted straight in and contact the back wall or other inserted wires for the full depth of the cup. (WB10)

15.5.6.8 Series Connected

- Stress relief radii between each terminal. (WB10)
- Turrets - Wire contacts base of terminal or a previously installed wire, and wraps around or interweaves each terminal. (WB10)
- Hooks - Wire wraps 360° around each terminal. (WB10)
- Bifurcated - Wire passes between posts and contacts base of terminal or previously installed wire. (WB10)
- Pierced/Perforated - Wire contacts two nonadjacent sides of each terminal. (WB10)

15.5.6.9 AWG30 and Smaller Diameter Wires

- Wire has two wraps (720°) around terminal post. (WB10)
- Wire does not overlap or cross over itself or other wires terminated on the terminal. (WB10)

15.5.7 Insulation

15.5.7.1 Clearance

- There is an insulation clearance of one wire diameter between the end of the insulation and the solder fillet. (WB10)

15.5.7.2 Damage

15.5.7.2.1 Presolder

- Insulation has been trimmed neatly with no signs of pinching, pulling, fraying, discoloration, charring or burning.

15.5.7.2.2 Post-Solder(WB10)

- Insulation is not melted, charred or otherwise damaged from the soldering process. (WB10)

15.5.7.3 Flexible Sleeve

- Insulation sleeving overlaps the connector terminal and extends over the wire insulation four wire diameters. (WB10)
- Insulation sleeving is one wire diameter from the point where the connector terminal enters the connector insert. (WB10)

15.5.8 Conductor

15.5.8.1 Deformation

- Strands are not flattened, untwisted, buckled, kinked or otherwise deformed. (WB17)

15.5.8.2 Strand Separation (Birdcaging)

- Original lay of strands is not disturbed. (WB17)

15.5.8.3 Damage

- Wires are not scraped, nicked, cut, flattened, scored, or otherwise damaged. (WB04)

15.5.9 Terminals – Solder

- 100% solder fillet around wire/lead and terminal interface (full extent of wrap). (SD02)
- Solder wets the wire/lead and terminal and forms a discernible fillet feathering out to a smooth edge. (SD02)
- Wire/lead is clearly discernible in the solder connection. (SD09)

15.5.9.1 Turret

- Lead outline is discernible, smooth flow of solder on wire and terminal. (SD02)
- Solder fillets at all points of wire/lead and terminal interface. (SD02)

15.5.9.2 Bifurcated

- Lead outline is discernible; smooth flow of solder on wire and terminal. (SD09)
- Solder fillets at all points of wire/lead and terminal interface. (SD02)

15.5.9.3 Slotted

- Solder forms a fillet with that portion of the lead or wire that is in contact with the terminal. (SD02)
- There is visible insulation clearance. (WB06)

15.5.9.4 Pierced Tab

- Lead outline is discernible; smooth flow of solder on wire and terminal. (SD09)
- Solder fillets at all points of wire/lead and terminal interface. (SD02)

15.5.9.5 Hook/Pin

- Lead outline is discernible; smooth flow of solder on wire and terminal. (SD09)
- Solder fillets at all points of wire/lead and terminal interface. (SD02)

15.5.9.6 Solder Cups

- Solder wets the entire inside of the cup. (SD02)
- Solder fill is 100%. (SD02)

15.5.10 Conductor – Damage – Post-Solder

- No birdcaging. (WB17)

15.6 Through-Hole Technology (Ref. Section 7 of IPC-A-610)

15.6.1 Component Mounting

15.6.1.1 Orientation

15.6.1.1.1 Horizontal

- Components are centered between their lands. (CM04)
- Component markings are discernible. MA01)
- Nonpolarized components are oriented so that markings all read the same way (left-to-right or top-to-bottom). MA03)

15.6.1.1.2 Vertical

- Nonpolarized component markings read from the top down. MA03)
- Polarized markings are located on top. MA03)

15.6.1.2 Lead Forming

15.6.1.2.1 Bends

- Leads for through-hole mounting extend at least one lead diameter or thickness but not less than 0.8 mm [0.031 in] from the body, solder bead, or lead weld. (CM21)
- Lead is not kinked or cracked. (CM05)
- The minimum inside bend radius of component leads meets requirements of Table 7-1 of IPC-A-610. (CM21)

15.6.1.2.2 Stress Relief

- Leads are formed to provide stress relief. (See IPC-A-610, Section 7.1.2.2) (CM21)
- Component lead exiting component body is approximately parallel to major body axis. (CM21)
- Component lead entering hole is approximately perpendicular to board surface. (CM21)
- Component centering may be offset as a result of the type of stress relief bend. (CM21)

15.6.1.2.3 Damage

- Component leads do not have nicks or deformation exceeding 10% of the diameter, width or thickness of the lead. (See exposed basis metal criteria.) (CM11)

15.6.1.3 Leads Crossing Conductors

- Sleeve does not interfere with formation of the required solder connection. (CM04)
- Sleeve covers area of protection designated. (CM04)

15.6.1.4 Hole Obstruction

- Parts and components are mounted such that they do not obstruct solder flow onto the primary side (solder destination side) lands of plated-through holes required to be soldered. (CM21)

15.6.1.5 DIP/SIP Devices and Sockets

- Standoff step on all leads rests on the land. (CM04)
- Lead protrusion meets requirements, see 15.6.4.3 and 15.6.5.3. (CM04)

15.6.1.6 Radial Leads – Vertical

- Component is perpendicular and base is parallel to board. (CM04)
- Clearance between base of component and board surface/land is between 0.3 mm [0.012 in] and 2 mm [0.079 in]. (CM04)

15.6.1.6.1 Spacers

- Spacer is in full contact with both component and board. (CM04)
- Lead is properly formed. (CM04)

15.6.1.7 Radial Leads – Horizontal

- The component body is in flat contact with the board's surface. (CM21)
- Bonding material is present, if required. See 15.6.3.2. (CM21)

15.6.1.8 Connectors

- Connector is flush with board. (CM04)
- Lead protrusion meets requirements. (CM21)
- Board lock (if equipped) is fully inserted/snapped into the board. (CM04)

15.6.1.9 High Power

- Hardware in proper sequence. (CM04)

- Leads on components attached by fastening devices are not clinched. (CM21)
- Insulating washer provides electrical isolation when required. (CM04)
- Thermal compound, if used, does not interfere with formation of required solder connections. (CM04)

15.6.2 Heatsinks

- Visual inspection needs to include hardware security, component or hardware damage, and correct sequence of assembly. (CM04)
- The following additional issues need to be considered:
 - (a) The component has good contact with the heatsink. (CM04)
 - (b) The hardware secures the component to the heatsink. (CM04)
 - (c) The component and heatsink are flat and parallel to each other. (CM04)
 - (d) The thermal compound/insulator (mica, silicone grease, plastic film, etc.) is applied properly. (CM04)
- Heatsinks are mounted flush. (CM04)
- No damage or stress on components. (CM04)

15.6.2.1 Insulators and Thermal Compounds

- Uniform border of mica, plastic film or thermal compound showing around edges of component. (CM04)

15.6.2.2 Contact

- Component and heatsink are in full contact with the mounting surface (CM04)
- Hardware meets specified attachment requirements. (CM04)

15.6.3 Component Securing

15.6.3.1 Mounting Clips

- Uninsulated metallic component insulated from underlying circuitry with insulating material. (CM04)
- Uninsulated metallic clips and holding devices used to secure components insulated from underlying circuitry with suitable insulating material. (CM04)
- Spacing between land and uninsulated component body exceeds minimum electrical clearance. (CM04)

15.6.3.2 Adhesive Bonding – Nonelevated Components (Does not apply to SMT)

- On a horizontally mounted component the adhesive adheres to component for at least 50% of its length, and 25% of its diameter, on one side. The build up of adhesive does not exceed 50% of the component diameter. Adhesion to the mounting surface is evident. The adhesive is approximately centered on the body. (BC04/BC05))
- On a vertically mounted component the adhesive adheres to the component for at least 50% of its length, and 25% of its circumference. Adhesion to the mounting surface is evident. (BC05)
- On multiple vertically mounted components the adhesive adheres to each component for at least 50% of its length, and the adhesion is continuous between components. (BC05)
- Adhesion to the mounting surface is evident. The adhesive also adheres to each component for a minimum 25% of its circumference. (BC05)
- Glass bodied components are sleeved, when required, prior to adhesive attachment. (BC06)
- Adhesives, e.g., staking, bonding, do not contact an unsleeved area of a sleeved glass body component. (BC06)

15.6.3.3 Adhesive Bonding – Elevated Components

- Bonding requirements should be specified in engineering documents, but as a minimum, components weighing 7g or more per lead are bonded to mounting surface in at least four places evenly spaced around component when no mechanical support is used. (BC05)
- At least 20% of the total periphery of the component is bonded. (BC05)
- Bonding material firmly adheres to both the bottom and sides of the component and to the printed wiring board. (BC05)

15.6.3.4 Wire Hold Down

- Component is held firmly against the mounting surface. (CM11)
- There is no damage to the component body or insulation from the securing wire. (CM11)
- Metal wire does not violate minimum electrical clearance. (CM21)

15.6.4 Unsupported Holes**15.6.4.1 Axial leads**

- The entire body length of the component is in contact with the board surface. (CM21)
- Components required to be mounted off the board are at minimum 1.5 mm [0.059 in] from the board surface; e.g., high heat dissipating. (CM21)
- Components required to be mounted off the board are provided with lead forms at the board surface or other mechanical support to prevent lifting of solder land. (CM21)

15.6.4.2 Vertical

- Components that are mounted above the board surface in unsupported holes are provided with lead forms or other mechanical support to prevent lifting of solder land. (CM21)

15.6.4.3 Wire/Lead Protrusion

Note: Lead protrusion (See Table 7-2 of IPC-A-610) should not allow a possibility of violating of minimum electrical clearance, damage to soldered connections due to lead deflection, or penetration of static protective packaging during subsequent handling. (CM21)

- The protrusion of leads and wires beyond the conductive surface is (L) or as specified on the specification or drawing. (CM21)

15.6.4.4 Wire/Lead Clinches

Note: Class 3 Lead terminations in unsupported holes are clinched a minimum of 45°. The clinch should be sufficient to provide mechanical restraint during the soldering process. The orientation of the clinch relative to any conductor is optional. DIP leads should be bent outward from the longitudinal axis of the body. Tempered leads and leads greater than 1.3 mm [0.050 in] should not be bent nor formed for mounting purposes. Tempered leads are not terminated with a full-clinched configuration. As a minimum, the lead is discernible in the completed solder connection. The lead meets the requirements of Table 7-2 of IPC-A-610 when measured vertically from the land surface and does not violate minimum electrical clearance requirements.

- Lead end is parallel to the board and direction of the clinch is along the connecting conductor. (CM21)

15.6.4.5 Solder

- Solder termination, (land and lead), covered with wetted solder and outline of lead discernible in the solder fillet. (SD11)
- No void areas or surface imperfections. (SD11)
- Lead and land are well wetted. (SD03)
- Lead is clinched. (CM21)
- 100% solder fillet around lead. (SD02)

15.6.4.6 Lead Cutting after Soldering

- The criteria in 15.6.5.5.8 are also applicable to solder connections in unsupported holes. (GN18)

15.6.5 Supported Holes**15.6.5.1 Axial Leaded – Horizontal**

- The entire body length of the component is in contact with the board surface. (CM21)
- Components required to be mounted off the board are at least 1.5 mm [0.059 in] from the board surface; e.g., high heat dissipating. (CM21)

15.6.5.2 Axial Leaded – Vertical

- The clearance of the component body or weld bead above the land is 1 mm [0.039 in]. (CM21)
- The component body is perpendicular to the board. (CM21)
- The overall height does not exceed the height specified. (CM21)

15.6.5.3 Supported Holes – Wire/Lead Protrusion

- Lead protrusion (Table 7-5 of IPC-A-610) should not allow a possibility of violating minimum electrical spacing, damage to soldered connections due to lead deflection, or penetration of static protective packaging during subsequent handling. (CM21)

15.6.5.4 Wire/Lead Clinches

- As a minimum, the lead is discernible in the completed solder connection. The lead meets the requirements of Table 7-5 of IPC-A-610 when measured vertically from the land surface and does not violate minimum electrical clearance requirements. (CM21)
- Lead end is parallel to the board and direction of the clinch is along the connecting conductor. (CM21)

15.6.5.5 Solder

- No void areas or surface imperfections. (SD11)
- Lead and land are well wetted. (SD04)
- Lead is discernible. (CM21)
- 100% solder fillet around lead. (SD02)
- Solder covers lead and feathers out to a thin edge on land/conductor. (SD02)
- No evidence of fillet lifting. (SD05)

15.6.5.5.1 Vertical Fill

- There is 100% fill. (SD02)

15.6.5.5.2 Primary Side – Lead to Barrel

- 360° wetting present on lead and barrel. (SD02)

15.6.5.5.3 Primary Side – Land Coverage Area

- The land area does not need to be wetted with solder on the primary side. (SD02)

15.6.5.5.4 Secondary Side – Lead to Barrel

- Minimum 330° fillet and wetting (lead, barrel and termination area). (SD02)
- 15.6.5.5.5 Secondary Side – Land Coverage Area**
 - Land area completely covered on the secondary side. (SD02)
- 15.6.5.5.6 Solder Conditions – Solder in Lead Bend**
 - Solder in lead bend area does not contact the component body. (SD09)
- 15.6.5.5.7 Meniscus in Solder**
 - There is 1.2 mm [0.048 in] separation between the coating meniscus and the solder fillet. (CM21)
- 15.6.5.5.8 Lead Cutting after Soldering**
 - No fractures between lead and solder. (SD05)
 - Lead protrusion within specification. (SD12)
- 15.6.5.5.9 Coated Wire Insulation in Solder**
 - Clearance of one wire diameter between solder fillet and insulation. (WB06)
- 15.6.5.5.10 Interfacial Connection without Lead – Vias**
 - Holes are completely filled with solder. (SD02)
 - The tops of lands show good wetting. (SD03)

15.7 Surface Mount Assemblies (Ref. Section 8 of IPC-A-610)

15.7.1 Staking Adhesive

- No adhesive present on solderable surfaces of the termination area. (BC04)
- Adhesive is centered between the lands. (BC06)

15.7.2 SMT Connections

15.7.2.1 Chip Components – Bottom Only Terminations

- Discrete chip components, leadless chip carriers, and other devices that have metal terminations on the bottom side only must meet the dimensional and solder fillet requirements listed in Table 8-1 of IPC-A-610.
- No side overhang. (CM19)
- End overhang in Y axis is not permitted. (CM19)
- End joint width is equal to the width of the component termination or width of land, whichever is less. (SD02)
- Side joint length equals component termination length. (SD02)
- Maximum fillet height requirements are not specified for Class 1,2,3.
- Minimum fillet height requirements are not specified for Class 1,2,3. However, a wetted fillet is evident.
- Wetting is evident. (SD02)
- Evidence of overlap contact between the component termination and the land is required. (CM19)

15.7.2.2 Chip Components – Rectangular or Square End Components (1, 3 or 5 Side termination)

- Solder connections to components having terminations of a square or rectangular configuration must meet the dimensional and solder fillet requirements listed in Table 8-1 of IPC-A-610. For 1 sided termination, the solderable side is the vertical end face of the component.
- No side overhang. (CM19)
- No end overhang. (CM19)
- End joint width is equal to component termination width or width of land, whichever is less. (SD02)
- Side joint length equals length of component termination. (SD02)
- Maximum fillet height is the solder thickness plus component termination height. (SD09)

- Minimum fillet height is solder thickness plus 25% termination height, or 0.5 mm [0.02 in], whichever is less. (SD02)
- Wetted fillet evident. (SD02)
- Evidence of overlap contact between the component termination and the land is required. (CM19)
- For chip components that may flip (rotate) onto the narrow edge during assembly.
 - (a) Width to height ratio does not exceed two to one (2:1) ratio. (CM04)
 - (b) Complete wetting at land to end cap metallization. (CM04)
 - (c) Overlap contact between 100% of the component termination (metallization) and the land. (CM04)
 - (d) Component has three or more termination faces (metallization). (CM04)
 - (e) There is evidence of wetting on the three vertical faces of the termination area. (CM04)
 - (f) Element of chip component with exposed deposited electrical element is mounted away from the board. (CM04)
 - (g) No stacking of components unless permitted by drawing. (CM04)
 - (h) All components meet the criteria of Table 8-2 of IPC-A-610, features B through W for the applicable class of acceptance. (CM04)
 - (i) Side overhang does not preclude formation of required solder fillets. (CM04)

15.7.2.3 Cylindrical End Cap (MELF) Termination

- Solder connections to components having cylindrical end cap terminations must meet the dimensional and solder fillet requirements of Table 8-3 of IPC-A-610.
- No side overhang. (CM19)
- No end overhang. (CM19)
- End joint width is equal to or greater than the component diameter or width of the land, whichever is less. (SD02)
- Side joint length is equal to the length of component termination or land length whichever is less. (SD02)
- Maximum fillet height may overhang the land and/or extend onto the top of the end cap metallization, but not extend further onto the component body. (SD09)
- Minimum fillet height is solder thickness plus 25% diameter of the component end cap or 1.0 mm [0.039 in], whichever is less. (SD02)
- Wetted fillet evident. (SD02)
- End overlap between the component termination and the land is minimum of 75% the length of component termination. (CM19)

15.7.2.4 Castellated Terminations

- Connections formed to castellated terminations of leadless chip components must meet the dimensional and solder fillet requirements listed in Table 8-4 of IPC-A-610. The solder fillet may contact the bottom of the component.
- No side overhang. (CM19)
- No end overhang. (CM19)
- End joint width (C) is equal to castellation width (W). (SD02)
- Solder extends from the back of the castellation onto the land at or beyond the edge of the component. (SD02)
- The fillet extends to the top of the castellation. **Note:** There is no maximum fillet height defect. (SD02)

- Minimum fillet height (F) is the solder thickness (G) (not shown) plus 50% castellation height (H). (SD02)
- Wetted fillet evident. (SD02)

15.7.2.5 Flat Ribbon, L, and Gull Wing Leads

- Flat ribbon, L, and Gullwing leaded devices must meet the dimensional and solder fillet requirements listed in Table 8-5 of IPC-A-610.
- No side overhang. (CM19)
- Toe overhang does not violate minimum electrical clearance. (CM19)
- End joint width is equal to or greater than lead width. (SD02)
- Evidence of wetted fillet along full length of lead. (SD02)
- Heel fillet extends above lead thickness but does not fill upper lead bend. (SD09)
- Solder does not contact the component body. (SD09)
- Heel fillet height (F) is greater than solder thickness (G) plus lead thickness (T) but does not extend into knee bend radius. (SD02)
- Wetted fillet evident. (SD02)
- Component lead(s) shall not be out of alignment (coplanarity), thus preventing the formation of an acceptable solder joint. (CM19)

15.7.2.6 Round or Flattened (Coined) Leads

- Round or flattened (coined) devices must meet the dimensional and solder fillet requirements listed in Table 8-6 of IPC-A-610.
- No side overhang. (CM19)
- Toe overhang is not specified. (CM19)
- Toe overhang does not violate minimum electrical clearance. (CM19)
- End joint width is equal to or greater than lead width/diameter. (SD02)
- Minimum side joint length is equal to 150% lead width/diameter. (SD02)
- Heel fillet extends above lead thickness but does not fill upper lead bend. (SD09)
- Solder does not contact the component body. (SD09)
- In the case of a toe-down configuration (not shown), the minimum heel fillet height extends at least to the midpoint of the outside lead bend. (SD02)
- Minimum heel fillet height is equal to solder thickness plus thickness of lead at joint side. (SD02)
- Wetted fillet evident. (SD02)
- Minimum side joint height is equal to or greater than solder thickness plus 50% diameter of round lead or 50% thickness of lead at joint side for coined lead. (SD02)
- Not one lead or series of leads on the component shall be out of alignment and fail to make contact with the land. (CM19)

15.7.2.7 J Leads

- Connections formed to leads having a J shape at the connection site must meet the dimensional and fillet requirements listed in Table 8-7 of IPC-A-610.
- No side overhang. (CM19)
- Toe overhang is an unspecified parameter. (CM19)
- End joint width is equal to or greater than lead width. (SD02)
- Side joint length is greater than 200% lead width. (SD02)
- Solder fillet does not touch package body. (SD09)
- Heel fillet height exceeds lead thickness plus solder thickness. (SD02)
- Wetted fillet evident. (SD02)
- Not one lead or series of leads on component is out of alignment and fails to make contact with the land. (CM19)

15.7.2.8 Butt/I Connections

- Butt connections are not permitted. (CM21)

15.7.2.9 Flat Lug Leads

- Connections formed to the leads of power dissipating components with flat lug leads must meet the dimensional requirements of Table 8-9 and Figure 8-134 of IPC-A-610. The design should permit easy inspection of wetting to the wettable surfaces. (GN04)

15.7.2.10 Tall Profile Components having Bottom Only terminations

- Connections formed to the termination areas of tall profile components (component height is more than twice width or thickness, whichever is less) having bottom only terminations must meet the dimensional requirements of Table 8-10 and Figure 8-136 of IPC-A-610. (GN04)

15.7.2.11 Inward Formed L-Shaped Ribbon Leads

- Connections formed to components having inward formed L-shaped lead terminations must meet the dimensional and solder fillet requirements of Table 8-11 and Figure 8-137 of IPC-A-610. (CM21)

15.7.2.12 Surface Mount Area Array

- Nonconformance to the requirements of Table 8-12 of IPC-A-610 is a defect when visual inspection or X-Ray inspection is performed to verify product acceptance.
- Placement of the BGA solder ball is centered and shows no offset of the ball to land centers. (CM19)
- BGA solder balls do not violate minimum electrical clearance. (SD14)
- The BGA solder ball terminations are uniform in size and shape. (SD18)
- 25% or less voiding of the ball x-ray image area. (SD11)
- Required underfill or staking material is present. (BC01)
- Underfill or staking material completely cured. (BC03)

15.7.2.13 Plastic Quad Flat Pack – No Leads (PQFN)

- Some other names for these devices are Microlead Packages, Leadless Plastic Chip Carriers (LPCC), and Quad Flat Pack No-Lead Exposed Pad (QFN-EP). Nonconformance to the dimensional and visual requirements of Table 8-13 of IPC-A-610 is a defect. (CM19)

15.7.2.14 Components with Bottom Thermal Plane Terminations

- Nonconformance to the dimensional and visual requirements of Table 8-14 of IPC-A-610 is a defect.
- No thermal plane side overhang. (CM19)
- Thermal plane termination edges have 100% wetting. (SD02)

15.8 Component Damage (Ref. Section 9 of IPC-A-610)**15.8.1 Loss of Metallization and Leaching**

- Leaching on any edge less than 25% of the component width or the component thickness. (CM08)
- Maximum of 50% of metallization loss of top metallization area (for each terminal end). (CM08)

15.8.2 Chip Resistor Element

- For chip resistors, any chip-out (nick) of the top surface (adhesive coating) of 1206 and larger component is less than 0.25 mm [0.00984 in] from the edge of the component. (CM11)
- No damage to the resistive element in area B of Figure 9.7 of IPC-A-610. (CM11)

15.8.3 Leaded/Leadless Devices

- Finish not damaged. (CM11)
- Component bodies are free of scratches, cracks, chips, and crazing. (CM11)
- ID markings are legible. MA01)

15.8.4 Chip Components

- No nicks, cracks, or stress fractures. (CM11)
- 15.8.5 Connectors**
- No discernable physical damage. (CM11)
 - No burrs on housing/shroud. (CM11)
 - No cracks in housing/shroud. (CM11)

15.9 Printed Circuit Boards and Assemblies (Ref. Section 10 of IPC-A-610)

15.9.1 Gold Fingers

- See IPC-A-600 and IPC-6010 (Series) for further criteria on gold fingers.
- Inspection is typically accomplished without magnification or lighting aids. However, there may be instances where these aids are needed; e.g., pore corrosion, surface contamination.
- Critical contact area (any portion of the fingers that contacts the mating surface of the connector) is dependent upon the connector system scheme being used by the manufacturer. The documentation should identify those particular dimensions.
- No contamination on gold fingers. (SD14)
- Solder is allowed in noncontact areas of fingers. (SD14)

15.9.2 Laminate Conditions

15.9.2.1 Measling and Crazing

- No evidence of measling (an internal condition occurring in laminated base material in which the glass fibers are separated from the resin at the weave intersection. This condition manifests itself in the form of discrete white spots or crosses below the surface of the base material, and is usually related to thermally induced stress.) (PC01)
- No evidence of crazing (an internal condition occurring in laminated base material in which the glass fibers are separated from the resin at the weave intersections. This condition manifests itself in the form of connected white spots or crosses below the surface of the base material and is usually related to mechanically induced stress.) (PC01)

15.9.2.2 Blistering and Delamination

- No blistering (delamination in the form of a localized swelling and separation between any of the layers of a lamination base material, or between base material and conductive foil or protective coating.) (PC01)
- No delamination (a separation between plies within a base material, between a base material and a conductive foil or any other planar separation with a printed board.) (PC01)

15.9.2.3 Weave Texture/Weave Exposure

- Weave texture (a surface condition of base material in which a weave pattern of glass cloth is apparent although the unbroken fibers are completely covered with resin) is an acceptable condition in all classes but is confused with weave exposure because of similar appearance.
- No weave exposure. (PC12)

15.9.2.4 Haloing and Edge Delamination

- No haloing (a condition existing in the base material in the form of a light area around holes or other machined areas on or below the surface of the base material) or edge delamination. (PC12)

15.9.2.5 Pink Ring

- There is no known evidence that pink ring affects functionality. The presence of excessive pink ring may be considered an indicator of process or design variation but is not a cause for rejection. The focus of concern is the quality of the lamination bond.

15.9.2.6 Burns

- No burns. (PC13)

15.9.2.7 Bow and Twist

- Bow and twist does not cause damage during post solder assembly operations or end use. Consider “Form, Fit and Function” and product reliability. (PC02)

15.9.2.8 Flexible and Rigid-Flex Printed Circuitry Burns

15.9.2.8.1 Nicks and Tears

- Free of nicks and tears. Minimum edge to conductor spacing maintained. (PC14)
- The trimmed edge of the flexible printed circuit or the flexible section of finished rigid-flex printed circuit is free of burrs, nicks, delamination, and tears. (PC14)

15.9.2.8.2 Stiffener Board Delamination

- The distance from stiffener board edge in the straight section is 0.5 mm [0.0197 in] or less. (BC04)
- The distance from stiffener board edge in the bend section is 0.3 mm or less. (BC05)

15.9.2.8.3 Discoloration

- No discoloration of conductors. A discolored conductor is acceptable if it meets the requirements of dielectric withstanding voltage, flexural fatigue resistance, bending resistance, and solder temperature resistance, after being subjected to the moisture resistance test of 40°C, 40% relative humidity, 96 hours. (PC14)

15.9.2.8.4 Solder Wicking

- Solder or plating on land covers all exposed metal and stops at coverlayer. (SD16)
- Solder wicking or plating migration does not extend into the bend or flex transition area. (SD09)

15.9.2.9 Conductors/Lands

15.9.2.9.1 Reduction in Cross-Sectional Area

- Conductor Imperfections - The physical geometry of a conductor is defined by its width x thickness x length. Any combination of defects does not reduce the equivalent cross-sectional area (width x thickness) of the conductor by more than 20% of the minimum value (minimum thickness x minimum width). (SD16)
- Conductor Width Reduction - Allowable reduction of the conductor width (specified or derived) due to isolated defects (i.e., edge roughness, nicks, pinholes and scratches) does not exceed 20% of the minimum printed conductor width. (SD09)

15.9.2.9.2 Lifted Pads/Lands

- No separation between conductor, pad or land and the laminate surface. (PC09)

15.9.2.9.3 Mechanical Damage

- No damage to conductors or lands. (CM11)

15.9.3 Marking

- The fabrication and assembly drawings are the controlling documents for the locations and types of markings. Marking criteria specified in the drawings will take precedence over these criteria.
- Assembly marking (part numbers, serial numbers) need to remain legible (capable of being read and understood as defined by the requirements of this standard) after all tests, cleaning and other processes to which the item is subjected. (MA01)

- Component markings, reference designators and polarity indicators should be legible and components should be mounted in such a manner that markings are visible. However, unless otherwise required, it is an acceptable condition if these markings are removed or damaged during normal cleaning or processing. Where component marking visibility and legibility is desired, the requirement needs to be stated in procurement documentation. (MA01)
- Acceptance of the marking is based on using the unaided eye. Magnification, if used, is limited to 4X.

15.9.3.1 Etched (Including Hand Printing)

- Each number or letter is complete, i.e., none of the lines forming a character are missing or broken. (MA01)
- Polarity and orientation markings are present and legible. (MA01)
- Lines forming the character are sharply defined and uniform in width. (MA01)
- Minimum spacing requirements between active conductors have also been maintained between etched symbolization and active conductors. (MA03)

15.9.3.2 Screened

- Each number or letter is complete i.e., none of the lines forming a character are missing or broken. (MA01)
- Polarity and orientation markings are present and legible. (MA01)
- Lines forming the character are sharply defined and uniform in width. (MA01)
- Ink forming the markings is uniform, i.e., there are no thin spots or excessive build-ups. (MA01)
- The open areas within characters are not filled (applies to numbers 0, 6, 8, 9, and letters A, B, D, O, P, Q, R). (MA01)
- There are no double images. (MA01)
- Ink is confined to the lines of the character, i.e., there are no smeared characters and the build-up of material outside the characters is held to a minimum. (MA01)
- Ink markings may touch or cross over conductors but are no closer than tangent to a land. (MA01)

15.9.3.3 Stamped

- Each number or letter is complete, i.e., none of the lines forming a character are missing or broken. (MA01)
- Polarity and orientation markings are present and legible. (MA01)
- Lines forming the character are sharply defined and uniform in width. (MA01)
- Ink forming the markings is uniform, i.e., there are no thin spots or excessive build-ups. (MA01)
- The open areas within characters are not filled (applies to numbers 0, 6, 8, 9 and letters A, B, D, O, P, Q, R). (MA01)
- There are no double images. (MA01)
- Ink is confined to the lines of the character, i.e., there are no smeared characters and the build-up of material outside the characters is held to a minimum. (MA01)
- Ink markings may touch or cross over conductors but are no closer than tangent to a solderable land. (MA01)

15.9.3.4 Laser

- Each number or letter is complete, and legible, i.e., none of the lines forming a character are missing or broken. (MA01)
- Polarity and orientation markings are present and legible. (MA01)

- Lines forming the character are sharply defined and uniform in width. (MA01)
- Marking forming the characters is uniform, i.e., there are no thick or thin spots. (MA01)
- The open areas within characters are not filled (applies to numbers 0, 6, 8, 9 and A, B, D, O, P, Q, R). (MA01)
- Marking is confined to the lines of the character, i.e., do not touch or cross over solderable surfaces. (MA01)
- The depth of the marking does not adversely affect the function of the part. (MA01)
- There is no exposed copper when marking on the ground plane of printed circuit boards. (MA01)
- There is no delamination when marking on the printed circuit board dielectric. (MA01)

15.9.3.5 Labels

15.9.3.5.1 Bar Coding

- Acceptability requirements are the same as other types of markings except for legibility where machine readability replaces human readability. (MA04)

15.9.3.5.2 Readability

- No spots or voids on printed surfaces. (MA04)

15.9.3.5.3 Adhesion and Damage

- Adhesion is complete, shows no sign of damage or peeling. (MA04)

15.9.3.5.4 Position

- Label is applied in the required position. (MA01)

15.9.4 Cleanliness

15.9.4.1 Flux Residues

- Clean, no discernible residue. (SD17)

15.9.4.2 Particulate Matter

- No particular matter. (SD17)

15.9.4.3 Chlorides, Carbonates and White Residues

- No discernible residue. (SD17)

15.9.4.4 No-Clean Process - Appearance

- Flux residue on, around, or bridging between noncommon lands, component leads and conductors. (SD17)
- Flux residue does not inhibit visual inspection. (SD17)
- Flux residue does not inhibit access to test points of the assembly. (SD17)
- No finger prints in no-clean residue. (SD17)

15.9.4.5 Surface Appearance

- Slight dulling of clean metallic surfaces is acceptable. (SD17)

15.9.5 Coating

15.9.5.1 Solder Resist Coating

15.9.5.1.1 Wrinkling/Cracking

- There is no evidence of cracking of the solder resist after the soldering and cleaning operations. (PC12)

15.9.5.1.2 Voids and Blisters

- No blisters, scratches, voids or wrinkling evident under solder resist after soldering and cleaning operations. (PC12)

15.9.5.1.3 Breakdown

- Solder resist surfaces are not homogeneous and there is flaking or peeling over dielectric areas. (PC12)

15.9.5.1.4 Discoloration

- No discoloration of the solder resist material. (PC12)

15.9.5.2 Conformal Coating

15.9.5.2.1 General

- Conformal coatings should be transparent, uniform in color and consistency and uniformly cover the board and components. (CC02)
- Uniform coating distribution depends partly on the method of application and may affect visual appearance and corner coverage.
- Assemblies coated by dipping may have a drip line or localized build-up of the edge of the board. This build-up may contain a small amount of bubbles but it will not affect the functionality or reliability of the coating.

15.9.5.2.2 Coverage

NOTE: The assembly may be examined with the unaided eye. Materials that contain a fluorescent pigment may be examined with blacklight to verify coverage. White light may be used as an aid for examining coverage.

- No loss of adhesion. (CC03)
- No voids or bubbles. (CC03)
- No dewetting, mealing, peeling, wrinkles (nonadherent areas), cracks, ripples, fisheyes or orange peel. (CC03)
- No embedded/entrapped foreign material. (FD01)
- No discoloration or loss of transparency. (CC08)
- Completely cured and uniform. (CC02)

15.9.5.2.3 Thickness

- Coating meets the thickness requirements of Table 10-1 of IPC-A-610. (CC04)

15.10 Discrete Wiring (Ref. Section 11 of IPC-A-610)

15.10.3 Component Mounting – Connector Wire Dress Strain/Stress Relief

- Wires exiting connector are positioned as they would be at installation. (WB07)
- All wires are dressed with even bends to prevent stress at contact connections. (WB07)
- Shortest wires are in direct line with center axis of cable. (WB07)

15.11 High Voltage (Ref. Section 12 of IPC-A-610)

15.11.1 Terminals

15.11.1.1 Wires/Leads

- Balled solder connection has a completely rounded, continuous and smooth profile. (SD02)
- No evidence of sharp edges, solder points, icicles, inclusions (foreign material) or wire strands. (SD02/SD08/FD01)
- Insulation clearance as close to the solder connection as possible without being embedded. (WB06)

15.11.1.2 Bottom Terminations

- Wire/lead outline is discernible with a smooth flow of solder on wire/lead and terminal. Individual strands may be discernible. (SD02)
- No evidence of sharp edges, solder points, icicles, or inclusions (foreign material). (SD02/SD08/FD01)
- Balled solder connection does not exceed specified height requirements and meets all acceptable criteria for ball soldering. (DM21)

15.11.1.3 Terminals – Unused

- All sharp edges of the terminal are completely covered with a continuous smooth ball of solder. (SD02)

15.11.2 Solder Cups**15.11.2.1 Wires/Leads**

- Solder connection has an egg-shaped, spherical or oval profile that follows the contour of wire wrap. No evidence of sharp edges, solder points, icicles, inclusions (foreign material) or wire strands. (SD02/SD08/FD01)
- Balled solder connection does not exceed specified height requirements and meets all acceptable criteria for ball soldering. (DM21)

15.11.2.2 Unused

- Solder connection has an egg-shaped, spherical or oval profile. (SD02)
- No evidence of sharp edges, solder points, icicles or inclusions (foreign material). (SD02/SD08/FD01)
- Balled solder connection does not exceed specified height requirements and meets all acceptable criteria for ball soldering. (DM21)

15.11.3 Insulation

- Clearance is minimal so that insulation is close to the solder connection without interfering with formation of the required solder ball. (WB06)
- Insulation is free of any damage (ragged, charred, melted edges or indentations). (WB04)

15.11.4 Through-Hole Connections

- All sharp edges of the component lead are completely covered with a continuous smooth rounded layer of solder forming a solder ball. (SD02)
- Straight-through leads facilitate ball soldering. (SD02)
- Balled solder connection does not exceed specified height requirements. (DM21)

15.11.5 Flared Flange Terminals

- All edges of the terminal are completely covered with a continuous smooth layer of solder forming a solder ball. (SD02)
- Balled solder connection does not exceed specified height requirements. (DM21)

15.11.6 Other Hardware

- There is no evidence of burrs or frayed edges on the hardware. (HA07)

16.0 INSPECTION OF POTTING AND ENCAPSULATION (I.E. MOLDED PARTS – VISUAL AND DIMENSIONAL INSPECTION REQUIREMENTS)**16.1 General Requirements**

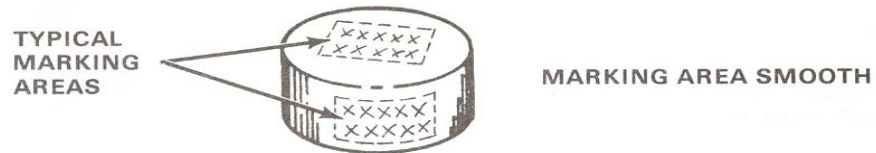
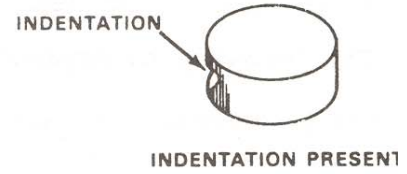
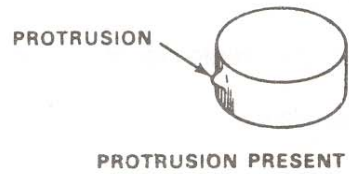
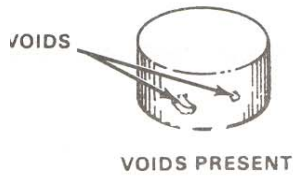
All visual and dimensional inspections performed on material or product manufactured by or purchased for use in the Lansdale facility shall be in accordance with the requirements of this product acceptance procedure.

16.1.1 General Condition

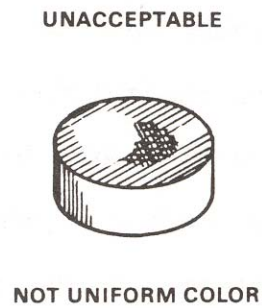
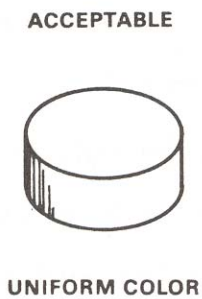
- The potting material surfaces shall be smooth, homogeneous, and uniform in appearance. Surface waviness and irregularity shall be within the limits of the process. The potting material surfaces shall be free from porosity, flash, loose potting, and uncured material; and they shall not exhibit any blistering, flaking, cracking, or inadequate bonding or adhesion to components. There shall be no strings, tails, peaks, globules, or misplaced material. Specified dimensions for potting shall be maintained and shall be within the limits defined by the assembly drawing. (CM14)

16.1.2 Marking Surface, Potted Units

- The Marking surface of the potted units shall be smooth so that applied markings will be legible. There shall be no voids, protrusions or indentations in the area designated for marking. (See Figure 16.1) (CM14)

FIGURE 16.1**Acceptable****Unacceptable****16.1.3 Potting Color Uniformity**

- Potting material shall be uniform in color. (See Figure 16.2) (CM14)

FIGURE 16.2**16.1.4 Cured Potting Material**

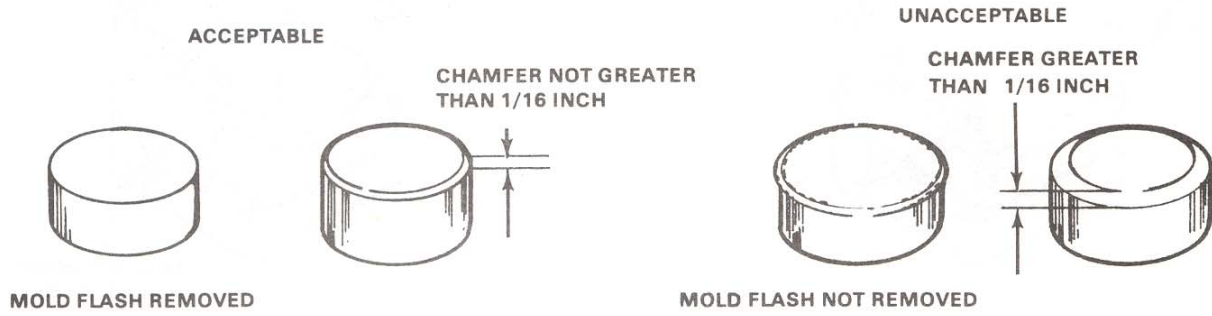
- Potting material shall be fully cured, and the surface shall not be tacky. (See Figure 16.3) (CM14)

FIGURE 16.3**16.1.5 Removal of Sprues**

- Sprues shall be fully removed where necessary, but the sprue-cut need not be smooth and glossy. Sprues may be partially removed, with a 1/32-inch maximum residue, if this partial removal does not affect the fit of the potted unit into the next assembly. (See Figure 16.4) (CM14)

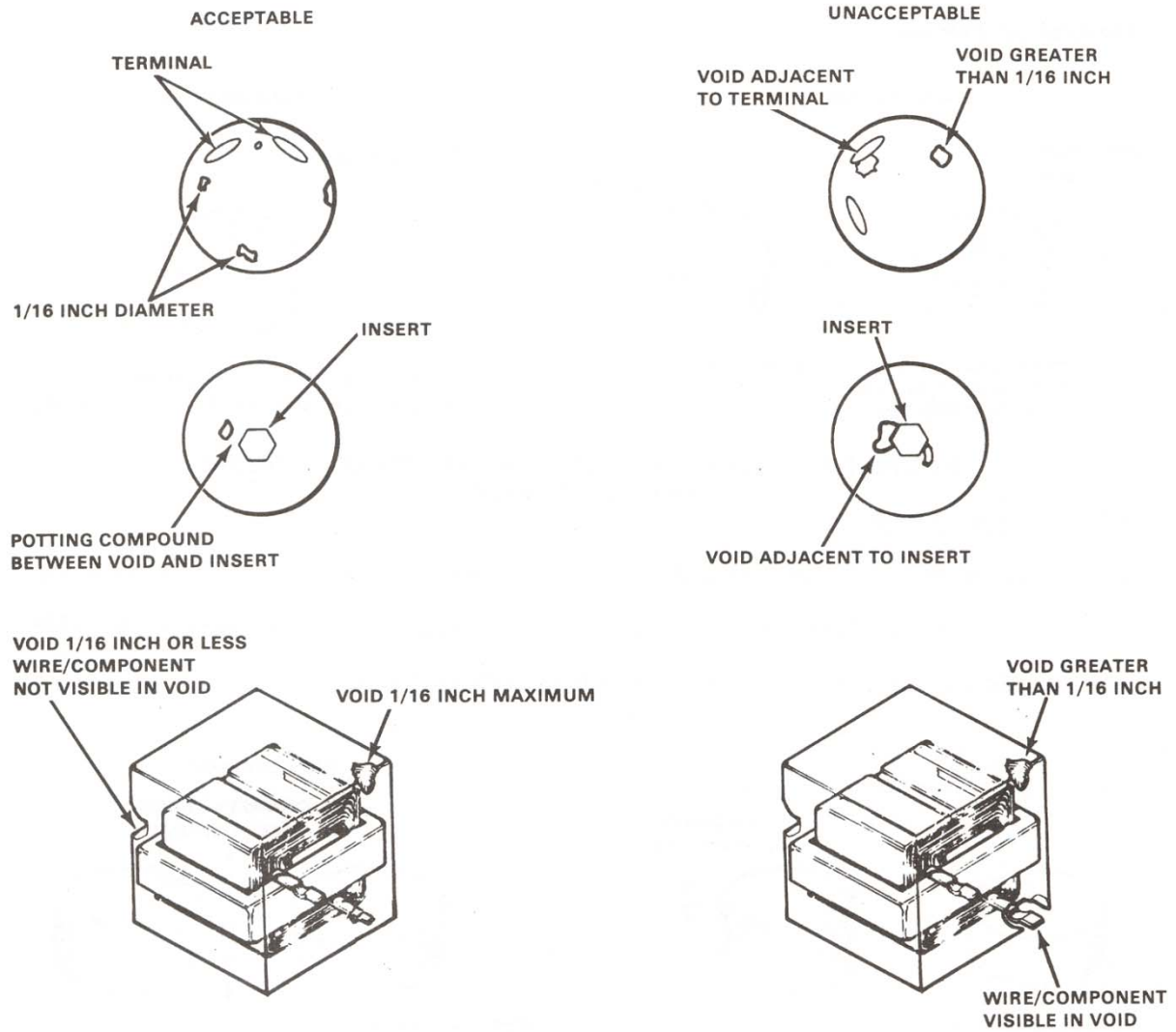
FIGURE 16.4**16.1.6 Mold Flash**

- When present after the potted unit is removed from the mold, mold flash shall be removed. Removal shall not result in the edges being chamfered more than 1/16-inch in width. (See Figure 16.5) (CM14)

FIGURE 16.5**16.1.7 Potting Voids**

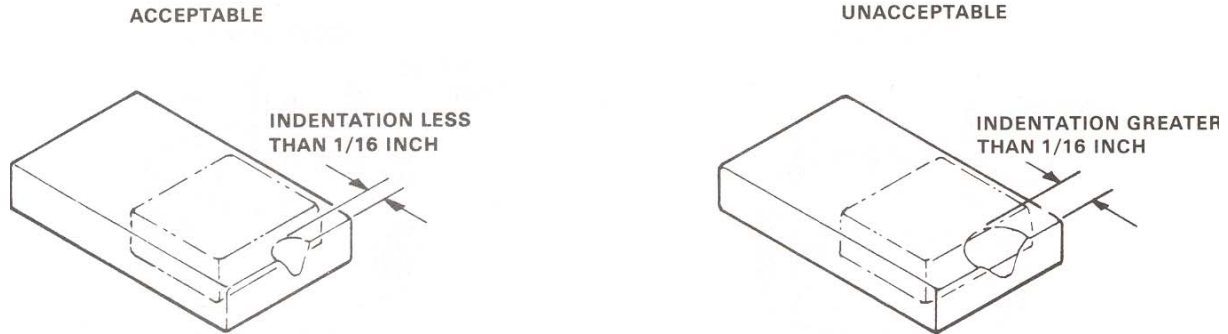
- Potting voids shall not exceed 1/16-inch in depth or width, and shall not be adjacent to terminals, inserts, or mounted hardware. Voids shall not expose potted components or wires. (See Figure 16.6) (CM14)

FIGURE 16.6

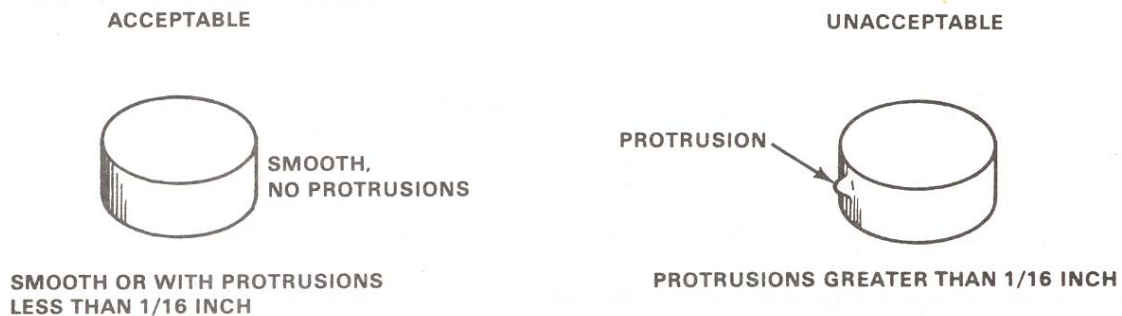


16.1.8 Potting Indentations

- When present, indentations shall not exceed 1/16-inch in depth or width, and shall not expose any components. (See Figure 16.7) (CM14)

FIGURE 16.7**16.1.9 Potting Protrusions**

- When present, protrusions shall not exceed 1/16-inch. If a protrusion occurs on a mounting surface of a potted assembly, it must be within the limits specified in paragraph 16.1.11.1. (See Figure 16.8) (CM14)

FIGURE 16.8**16.1.10 Potting Levels**

- Height of potting in potted assemblies shall be within the limits defined by the assembly drawing. (See Figure 16.9) (CM14)
- Connector shall be filled to within 1/8 to 1/32-inch of the top of the potting cup. (See Figure 16.10) (CM14)
- On open-end component assemblies with lead extensions, the allowed height above the potting level (meniscus level) shall be a maximum of 1/16-inch. (See Figure 16.11) (CM14)
- On open-end potted assemblies with wire or cable exits, the allowable rise of potting material on the wire or cable shall be no greater than 50% of the cable diameter. (See Figure 16.12) (CM14)

FIGURE 16.9

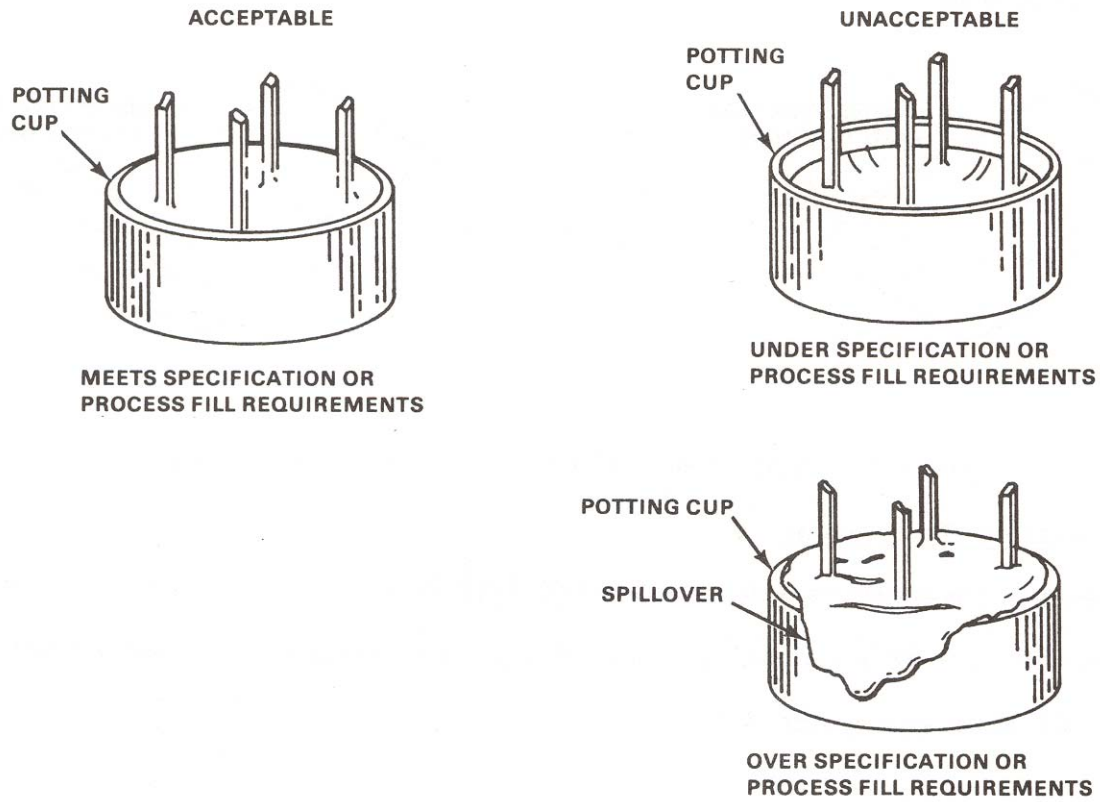


FIGURE 16.10

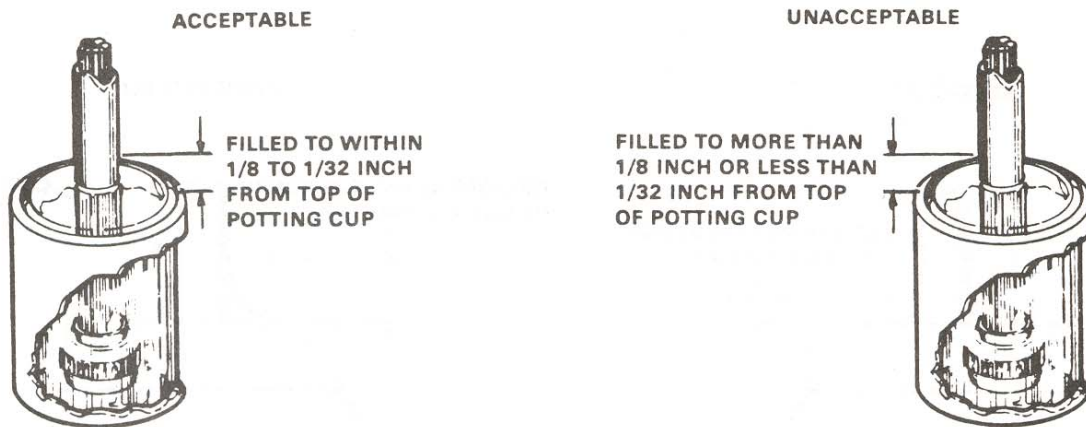
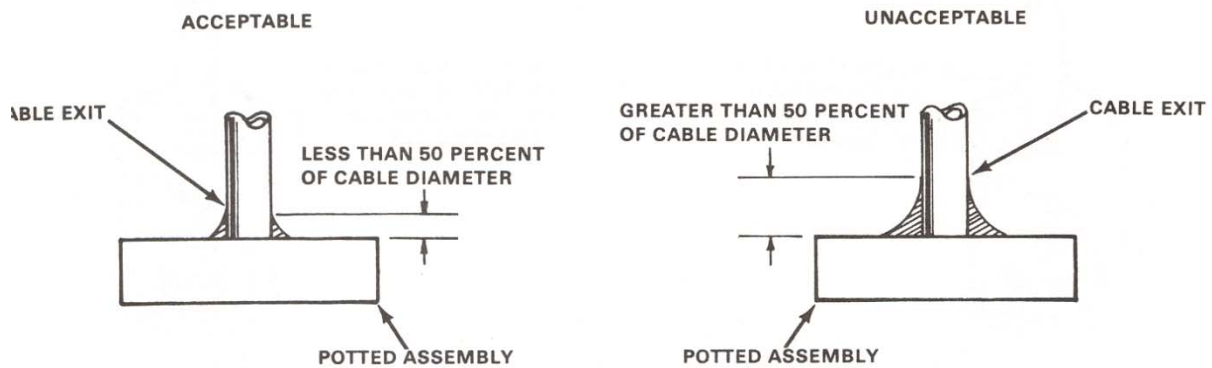
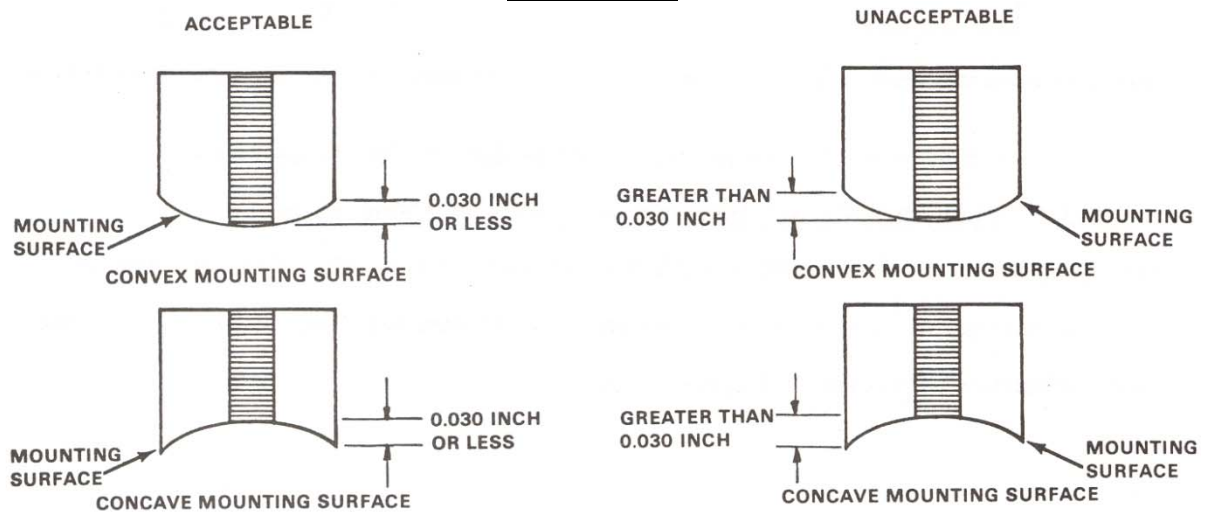


FIGURE 16.11**FIGURE 16.12**

16.1.11 Flatness of Mounting Surface

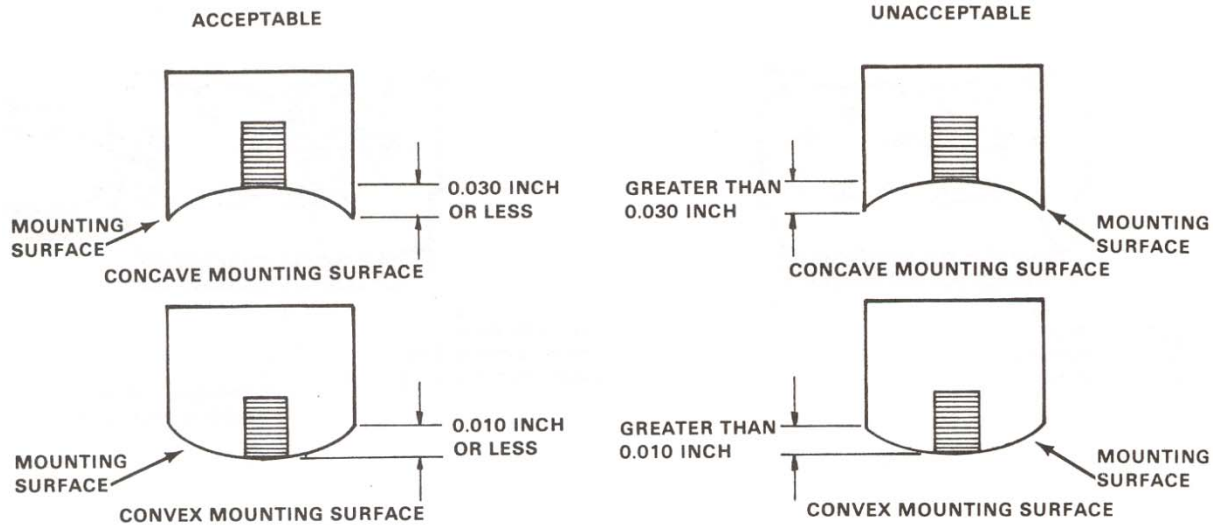
16.1.11.1 Through-Hole Mounting

- The mounting surface of the potted assembly shall not deviate from a flat surface by more than 0.030-inch. (See Figure 16.13) (CM14)

FIGURE 16.13

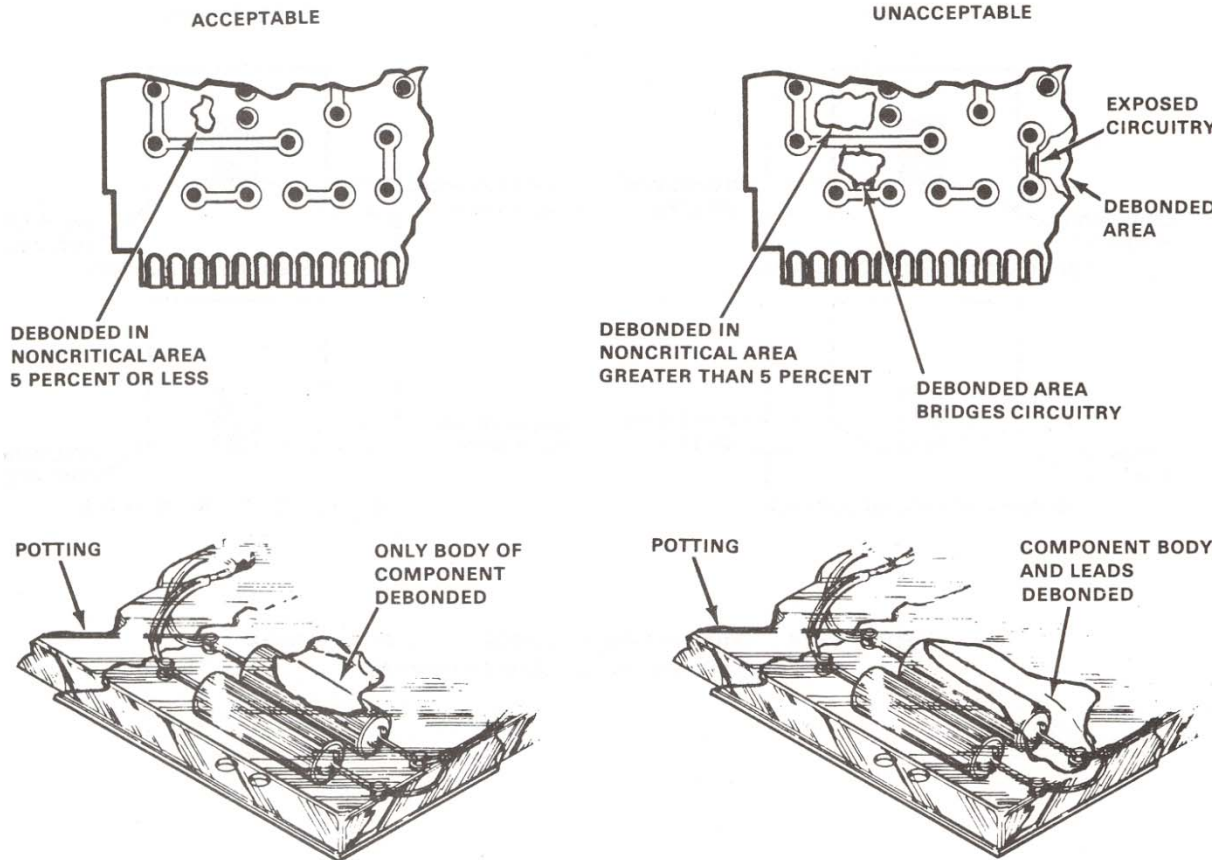
16.1.11.2 Insert Mounting

- The mounting surface of a potted assembly (using an internally secured insert to secure the assembly) shall not deviate by more than 0.030 inch, if the deviation is concave or more than 0.010 inch if the deviation is convex. (See Figure 16.14) (CM14)

FIGURE 16.14

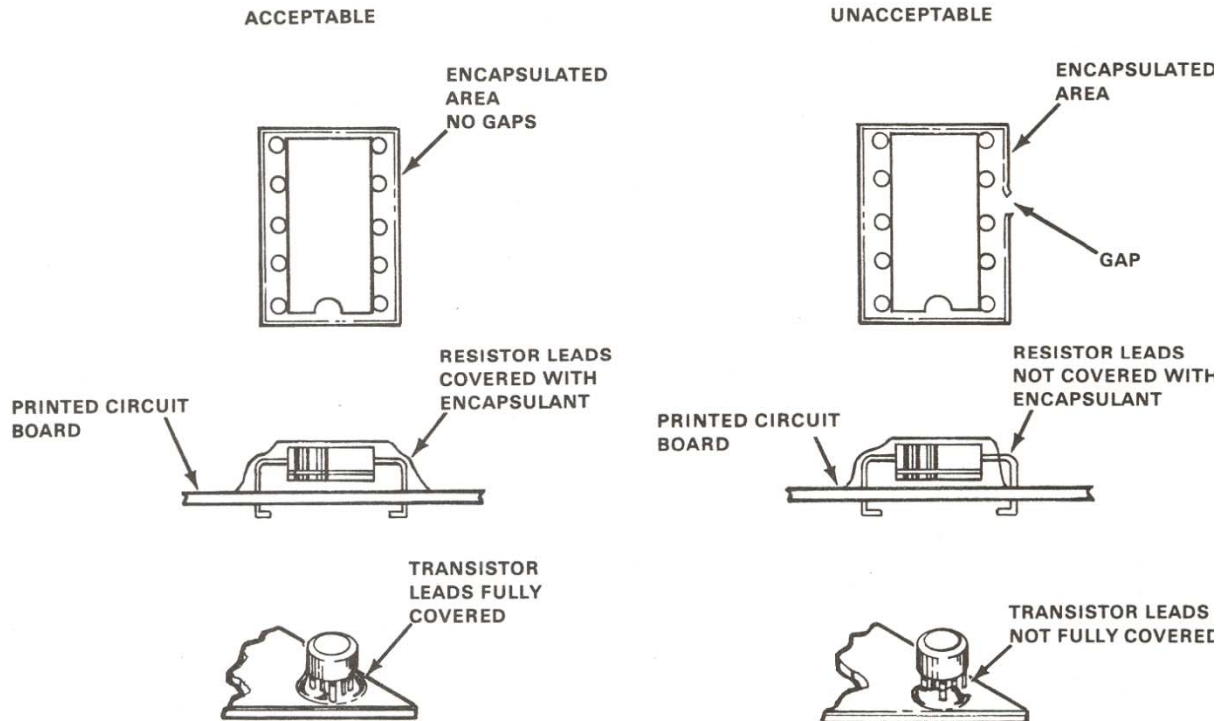
16.1.12 Debonding

- Any debonding that bridges or exposes circuitry shall be unacceptable. Debonding in non-critical areas, such as areas devoid of parts or circuitry or around insulated components, shall not exceed five percent of the total potted area. (See Figure 16.15) (CM14)

FIGURE 16.15

16.1.13 Encapsulation

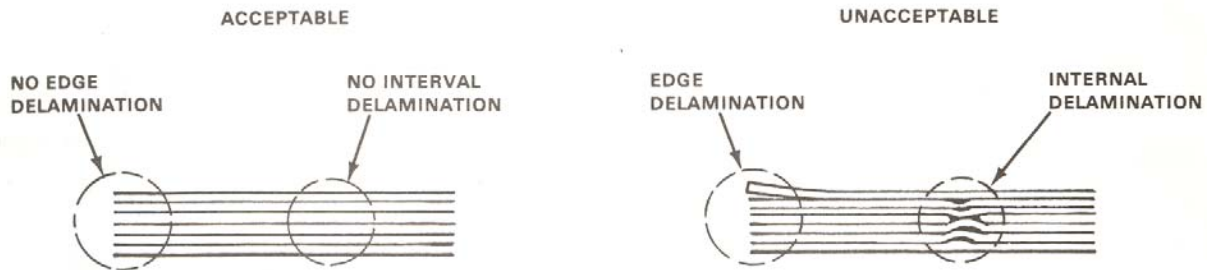
- Encapsulation is an operation normally applied to a specific area of a board or assembly that contains components sensitive to the environment. The area to be encapsulated shall be totally enclosed by the encapsulant, with no gaps or pinholes that could expose circuitry and a minimum thickness of 0.010 inch over exposed electrical leads or points. (See Figure 16.16) (CM14)

FIGURE 16.16**17.0 INSPECTION OF PLASTICS – VISUAL AND DIMENSIONAL INSPECTION REQUIREMENTS****17.1 General Requirements**

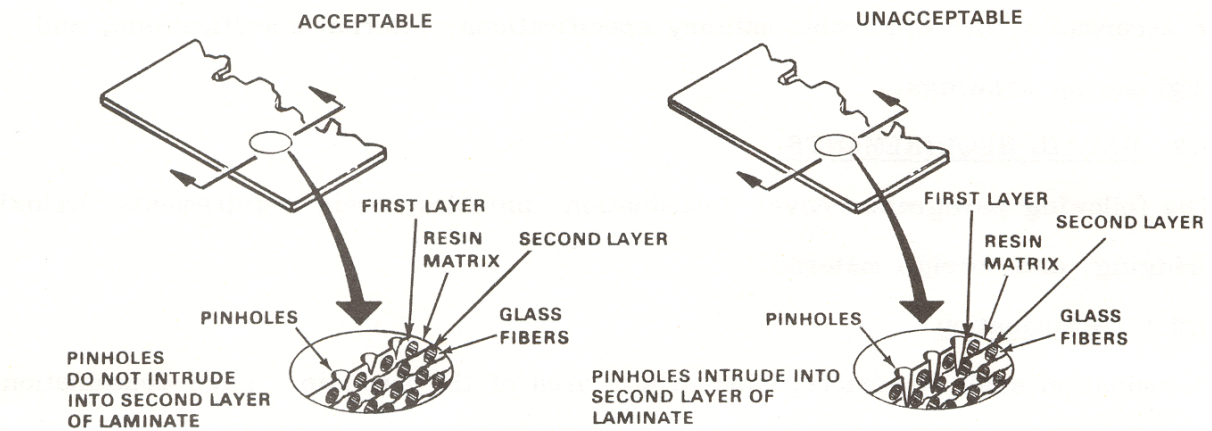
All visual and dimensional inspections performed on material or product manufactured by or purchased for use in the Lansdale facility shall be in accordance with the requirements of this product acceptance procedure. This section involves inspection criteria for the fabrication of thermosetting, resin-impregnated, woven fabric, and fibrous glass mats.

17.2 Delamination

Delamination shall be unacceptable in any area of the laminate. Edge delamination may be found by tapping the surface with a coin; if delamination is present, a change in sound (from solid to hollow) will be heard. (See Figure 17.1) (GN25)

FIGURE 17.1**17.3 Pinholes**

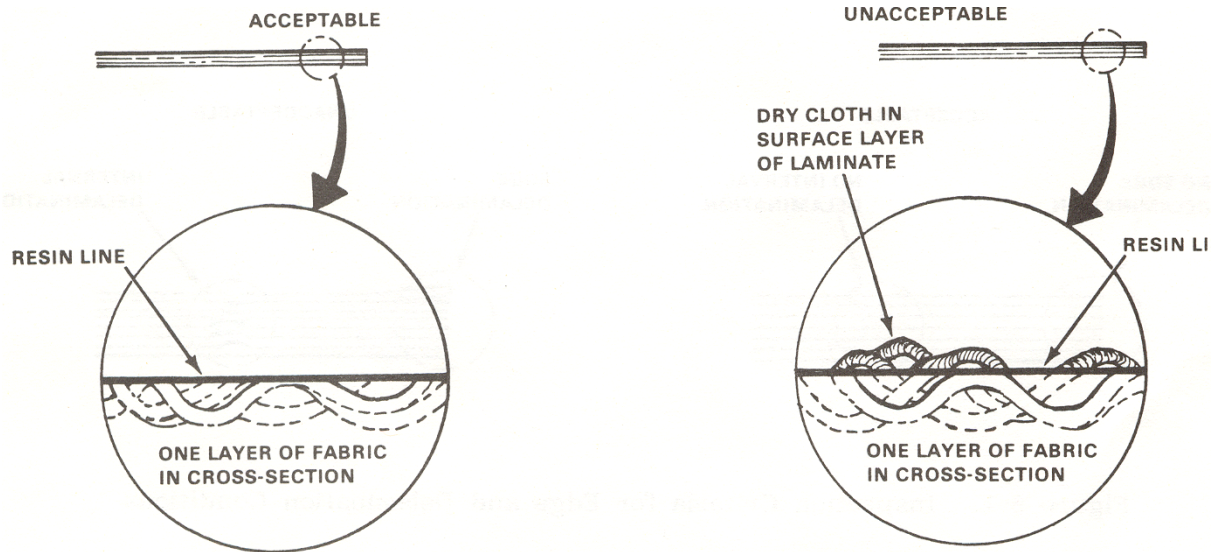
The presence of pinholes shall be acceptable provided that they do not intrude into the second layer of laminate, unless specified otherwise in the engineering drawing. (See Figure 17.2) (GN25)

FIGURE 17.2

17.4 Resin Requirements

Laminates shall be thoroughly covered with appropriate resin and free of resin-starved areas. (See Figure 17.3) (GN25)

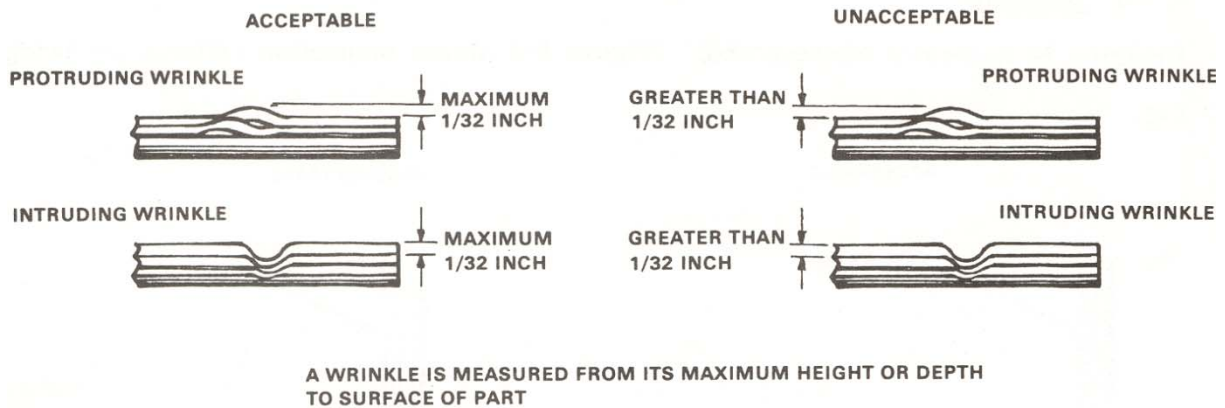
FIGURE 17.3



17.5 Wrinkles

Wrinkles shall be permitted on external and internal surfaces if the height or depth is limited to 1/32 inch higher or lower than the surrounding areas. (See Figure 17.4) (GN25)

FIGURE 17.4



17.5.1 Wrinkles in Critical Areas

In critical areas, wrinkles not more than $1/32$ inch higher than surrounding areas shall be allowed on the interior of a part, provided that not more than three inches of wrinkles are in an area encompassed by a six-inch diameter circle. A total of 12 inches of wrinkles in an area encompassed by a 3-foot diameter circle shall be the maximum permitted. (GN25)

17.5.2 Wrinkles in Noncritical Areas

In noncritical areas, wrinkles $1/32$ inch or less in height may be allowed up to a total of 12 inches, provided the structural serviceability shall be allowed in an area encompassed in a six-inch diameter circle. (GN25)

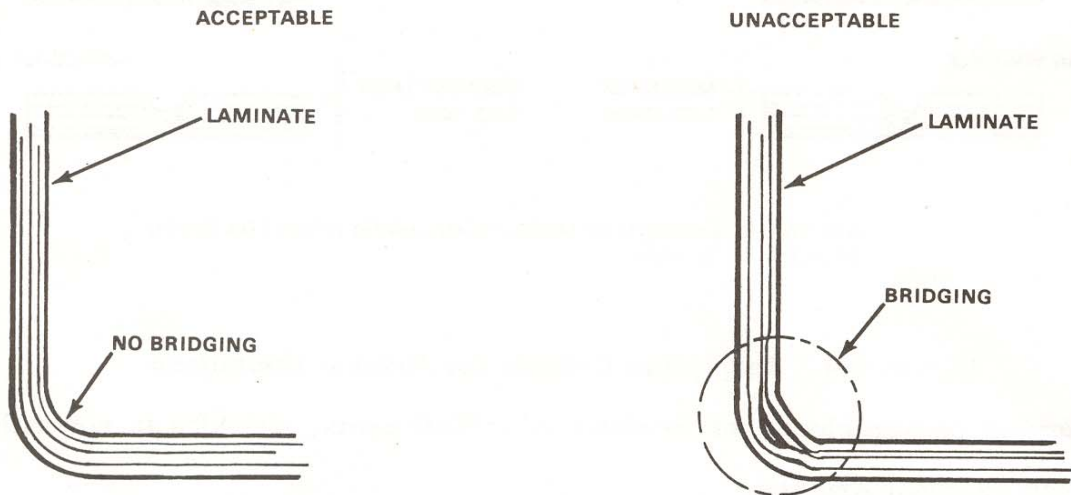
17.5.3 External Wrinkles

External wrinkles $1/32$ inch or less in height shall be permitted immediately adjacent to sharp changes in contour, provided the serviceability of the part is not affected. (GN25)

17.6 Bridging

Bridging is generally unacceptable. (See Figure 17.5) (GN25)

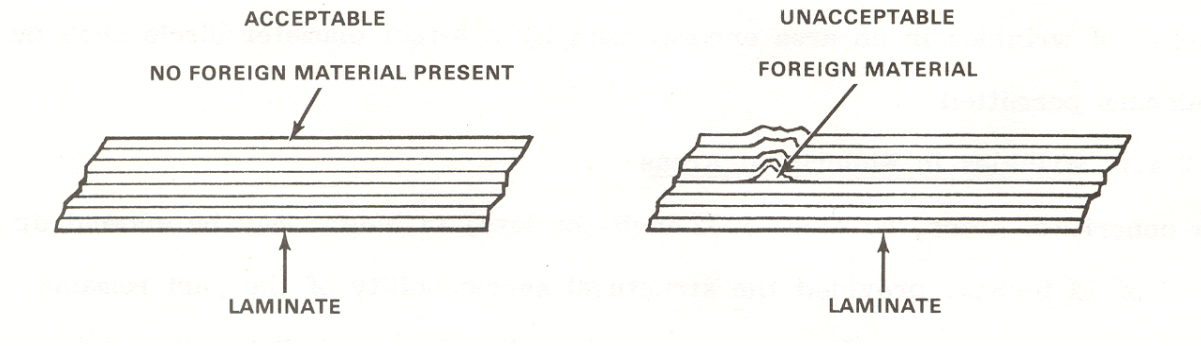
FIGURE 17.5



17.7 Foreign Material

No foreign material shall be present in a laminate. (See Figure 17.6) (GN25)

FIGURE 17.6



18.0 **INSPECTION OF HYBRIDS AND ACTIVE/PASSIVE ELEMENTS – VISUAL AND DIMENSIONAL INSPECTION REQUIREMENTS**

18.1 **General Requirements**

All visual and dimensional inspections performed on material or product manufactured by or purchased for use in the Lansdale facility shall be in accordance with the requirements of this product acceptance procedure.

18.2 **Inspection of Hybrid/Microwave Microcircuits**

- All hybrid/microwave microcircuits shall be internally inspected to Lansdale procedure 1652000.
- All hybrid/microwave microcircuits shall be externally inspected to Lansdale procedure 1611394.

18.3 **Inspection of Active Elements, i.e. Integrated Circuits, MMICs, Diodes and Transistors**

- All active elements shall be inspected to Lansdale procedure 1652476.

18.4 **Inspection of Passive Elements, i.e. Thin/Thick Film Substrates, Resistors, Capacitors, etc.**

- All passive elements shall be inspected to Lansdale procedure 1611276.

19.0 **INSPECTION OF BRAZING**

19.1 **General Requirements**

The inspection criteria for all brazing operations shall be in accordance with Lansdale procedure 1611704. (GN24)